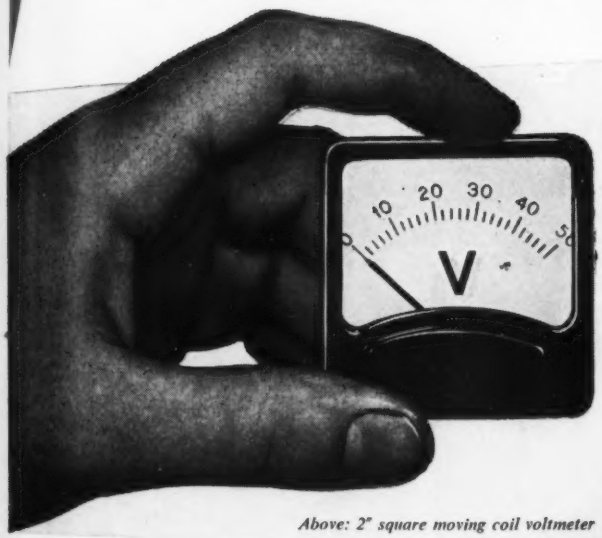
Circle 3 for further information

A COMPREHENSIVE RANGE OF "Miniature" Instruments



Above: 2" square moving coil voltmeter

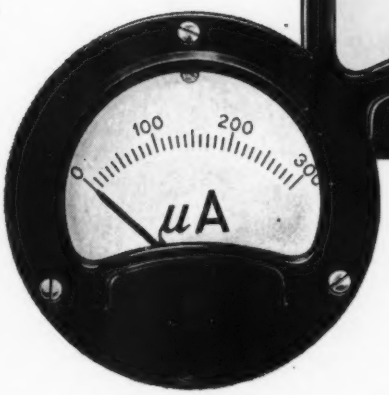
★ **DESIGNED TO HARMONISE WITH ALL MODERN ELECTRONIC EQUIPMENT**

★ **FIXINGS CONFORM TO ACCEPTED PRACTICE**

★ **PRICES ARE HIGHLY COMPETITIVE**

For utmost reliability all 'ENGLISH ELECTRIC' miniature instruments have been designed with a higher-than-normal torque/weight ratio in combination with lower power consumption. All types have been successfully subjected to the following tests:
RESISTANCE TO IMPACT SHOCK OF 200g in any plane.
VIBRATION FATIGUE TEST—two million cycles at peak resonant frequency.
OSCILLATORY TEST—up to one million operations.

Above: 3"x 4" rectangular absorption wattmeter



Left: 2½" round moving coil microammeter

SPECIFICATIONS B.S. 89–1954 and other International Specifications.

TYPES
Moving coil for D.C. applications.
Rectifier moving coil for A.F. applications.
Thermo-couple operated moving coil for R.F. applications.

SIZES
Square: 2", 2½" and 3½" nominal scale length.
Round: 2½" and 3½" nominal scale length.
Rectangular: 5"x 6" or 3"x 4" nominal case size.

Design registrations pending.

Over 50 standard ranges in any of the seven case types.

Delivery ex stock for standard ranges.

Non-standard ranges to customer's specification within 21 days.

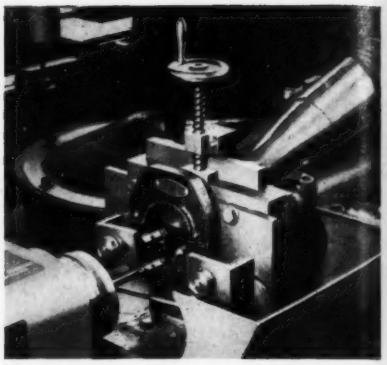
Literature available on request to The ENGLISH ELECTRIC Company Ltd., Instrument Department, Stafford.

'ENGLISH ELECTRIC'

THE ENGLISH ELECTRIC COMPANY LIMITED, MARCONI HOUSE, STRAND, LONDON, W.C.2
Meter, Relay and Instrument Division, Stafford
WORKS: STAFFORD · PRESTON · RUGBY · BRADFORD · LIVERPOOL · ACCRINGTON
INS.43A

Circle 4 for further information

The Caliper is normally supplied as a 'GO' and 'NOT GO' combination gauge so that both tests can be applied in one action, but is also available as 'GO' only or 'NOT GO' only.



A precision co-ordinate frame boring machine for ensuring parallelism and centre distance of anvil mountings.

Adjusting screws, protected by cover plates, allow for a wide range of work diameters and tolerances. The gauge, after long usage, can also be re-adjusted many times to size so that the necessity for regrinding is eliminated.

Featuring Horstmann gauges

The Horstmann Model 52 Screw Caliper Gauge puts accuracy in your hands. In addition to the features displayed above, it incorporates many other advantages, all of which contribute to fine accuracy, versatility, long life and ease of handling. The anvils are set so that they do not roll—all shearing action is eliminated—the caliper is suitable for either left- or right-hand threads—and it is ideal for gauging Acme forms and shouldered work. Model 52 is available in a full range of B.A., American, Unified, Whitworth and Metric forms of thread.

Horstmann also make screw and plain Plug and Ring type gauges. All these precision instruments are guaranteed for accuracy, hardness and finish to the requirements laid down by the National Physical Laboratory.

May we send you descriptive leaflets?

HORSTMANN

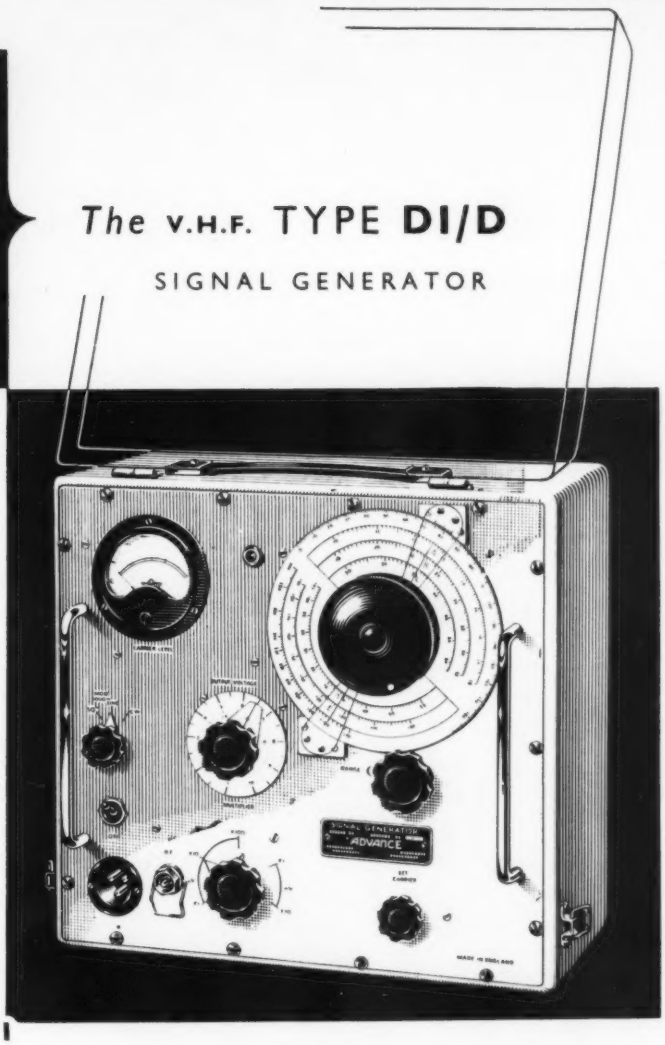
PLUG, RING & CALIPER GAUGES

THE HORSTMANN GEAR COMPANY LIMITED

Newbridge Works, Bath, England · Tel: 7241

10 to 300 Mc/s DIRECTLY CALIBRATED

The V.H.F. TYPE DI/D SIGNAL GENERATOR



The Type DI/D is a V.H.F. Signal Generator of rugged construction designed for both laboratory use and also the severe conditions of "the field". This instrument is widely used by communication engineers throughout the world, and has the following outstanding features:

- **Wide frequency range**—10 to 300 Mc/s
- **Reliable Attenuator:** Output variable over 100 dB from 1 μV to 100 mV
- **Negligible stray field**
- **Sine and Square Wave Modulation**

Nett Price in U.K.

£97

Full technical details in Leaflet C43

by

Advance —*to be sure!*

THE ADVANCE TYPE DIP/2 V.H.F. SIGNAL GENERATOR

This model is a special version of the DI/D designed for the alignment of narrow band communication receivers, and incorporates:

- Crystal Modulator, eliminating spurious frequency modulation
- 2 Mc/s Crystal Reference Oscillator
- Buffer stage, eliminating attenuator reaction on the oscillator frequency

Nett Price in U.K.

£110

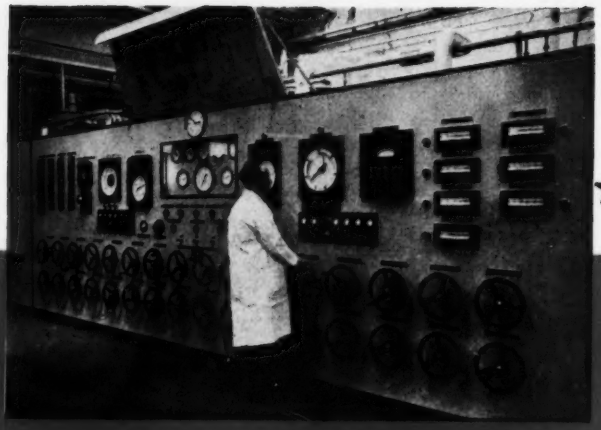
Full technical details in Leaflet C37

GD71 · *Advance* COMPONENTS LIMITED · ROEBUCK ROAD · HAINAULT · ILFORD · ESSEX · TELEPHONE: HAINAULT 4444

Circle 6 for further information

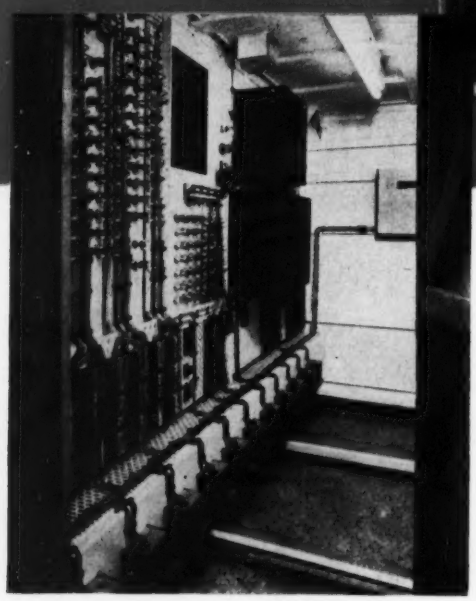
★ ★ ★ ★ ★ ★ ★ ★ ★ ★

Panels Wiring and Complete Instrument Installation



1. *Control Panel manufactured for Foster Wheeler Rolls-Royce Facility Test Rig Project.*

2. *Final inspection before despatch from our factory at Colnbrook.*



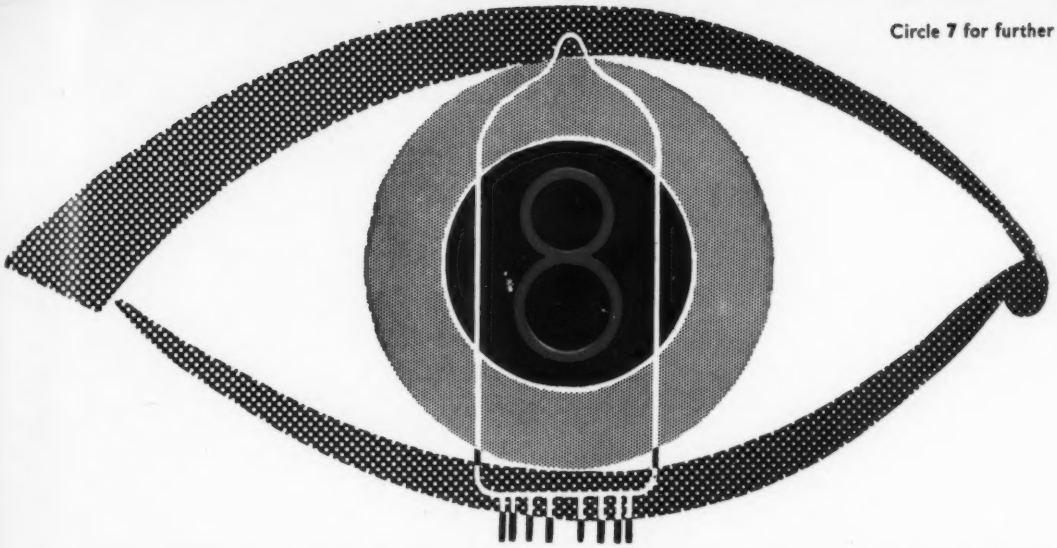
3. *Panels completely piped and wired by fully trained technicians*

Our Company are specialist panel manufacturers and Instrument Installation Contractors, we also undertake the design and engineering of instrument projects for Industrial and Nuclear application.

R. HUTCHEON DUTHIE & SON LTD.

18 DAVID ROAD, POYLE TRADING ESTATE, COLNBROOK, BUCKS. *Telephone Colnbrook 2206*

Circle 7 for further information



INSTANTANEOUS READOUT

with the wide-angle side-viewing

DIGITRON*

The new Ericsson register tube which gives direct numerical display for all digital applications.

The Digitron consists of 10 cathode assemblies arranged to display the numbers 0 to 9 according to the cathode energised.

Number delineation takes full advantage of the essentially rectangular vertical cross-section of the glass envelope and is based on a display area of 30 mm x 17 mm. This represents a considerable increase in both character size and visibility range over end viewing presentation. Further, by adopting such a method of display, an unrestricted view of the numbers is obtained over viewing angles of 60° either side of tube normal without any distortion.

Displayed data can be quickly assimilated without ambiguity by either individuals or groups at distances up to 50 feet over a viewing arc of 120°.

Also available and matching the DIGITRON GR 10 G in size and clarity of readout is the DIGITRON GR 4 G fraction tube which displays "1", "½", "⅓" & ¼.

If you would like more information about the DIGITRON TYPES GR10G and GR4G or have any problems concerning digital display please write to:

THE TECHNICAL SERVICES DEPT.,

ERICSSON

TUBE DIVISION, BEESTON, NOTTINGHAM.

ERICSSON TELEPHONES LIMITED, HEAD OFFICE: 22 LINCOLN'S INN FIELDS, LONDON W.C.2. Tel HOLborn 6936.

* DIGITRON IS AN ERICSSON TRADE MARK

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Circle 8 for further information

A matter of degree...

Day in, day out, year in and year out the healthy human body is temperature controlled at a steady 98·4° Fahrenheit—and without using electronics or thermocouples.

We "The Pyrometer People"—cast in the common mould—play our part in keeping the industrial body well controlled with instruments which also stand the test of time because they are designed and built by craftsmen who take pride in a job well done. In fact, we are old fashioned enough to believe that British craftsmanship is still highly regarded by the discerning purchaser.

As one of the largest firms in Europe devoted *entirely to pyrometry with nearly fifty years' experience behind us we welcome enquiries from anywhere in the world on the problems associated with temperature measurement and control, and after sales our Service Contract Scheme ensures the continued accuracy of our equipment. These are points to remember when the occasion arises. In the meantime send for our descriptive literature — we shall be happy to show you the things we make.

ELECTRICAL RESISTANCE THERMOMETERS
THERMO-ELECTRIC PYROMETERS
TOTAL RADIATION PYROMETERS
OPTICAL PYROMETERS
PHOTO-ELECTRIC PYROMETERS

**Sorry, this is not strictly true, we do make the incomparable Introscopes for internal inspection.*

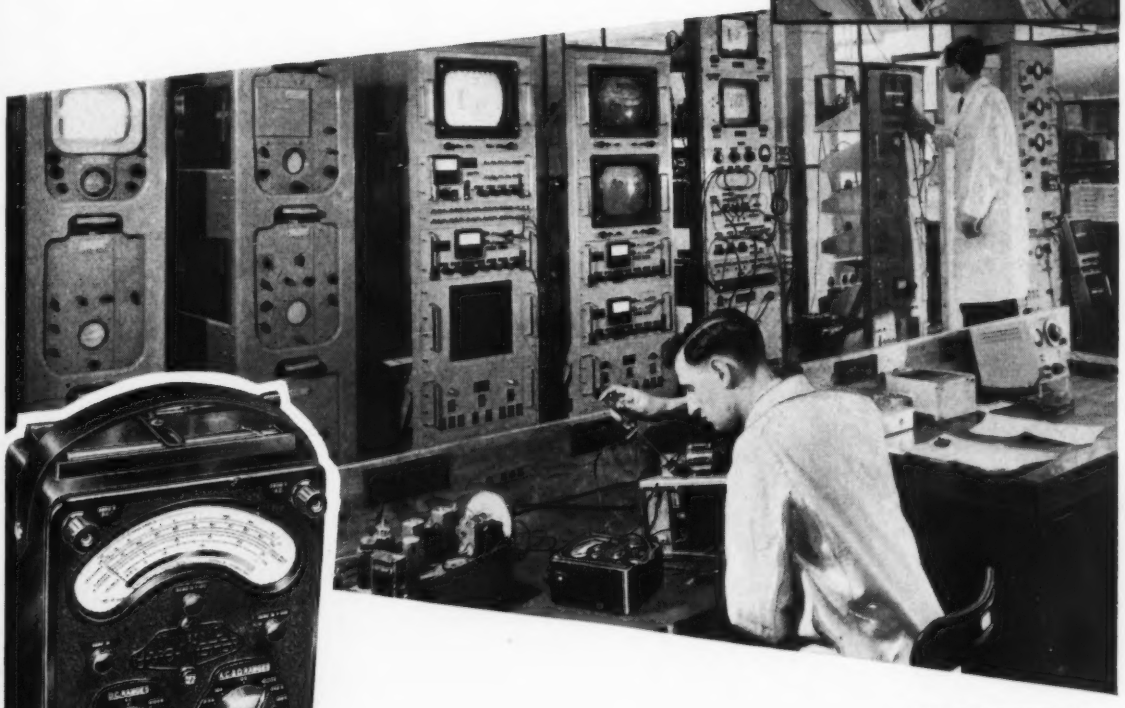
"The Pyrometer People"
FOSTER INSTRUMENT COMPANY LIMITED
Letchworth (984-3-6) Hertfordshire · England
Members of S.I.M.A. and B.I.M.C.A.M.

Think of RESILIA **FOSTER** / ***first for temperature measurement and control***

Circle 9 for further information

FERGUSON choose the Model 8 AvoMeter

for their Television & Electronic Laboratory



Photograph by courtesy of Thorn Electrical Industries Ltd.

A.C. VOLTAGE: 25 mV. to 2,500 volts.
A.C. CURRENT: 1 mA. to 10 amps.
D.C. VOLTAGE: 25 mV. to 2,500 volts.
D.C. CURRENT: 0.5 microamps to 10 amps.
SENSITIVITY:
20,000 ohms per volt on all D.C. ranges.
1,000 ohms per volt on A.C. ranges from 100 volts upwards.
RESISTANCE:
0 to 20 megohms (using internal batteries).
0 to 200 megohms (using external D.C. supply).
DECIBELS: —15dB to + 15dB.

Various accessories are available for extending the above ranges.

FERGUSON are typical of the many leading manufacturers of electronic, radio and television equipment who rely on AVO instruments.
The Model 8 AvoMeter shown in use is a 30-range self-contained A.C./D.C. moving coil instrument, produced primarily for the electronic, radio and television engineer. The upper photograph shows a mounted pivot under examination. This is only one of many operations carried out in a special air-conditioned dust-free zone in the AVO factory to ensure the highest possible standards of accuracy and reliability.

Size: 8¼ x 7½ x 4½ inches.
Weight: 6¼ lbs. (approx.) including leads.

List Price: **£23 : 10s.**

AVO LTD

AVOCET HOUSE · 92-96 VAUXHALL BRIDGE ROAD · LONDON · S.W.1
Telephone: VICtoria 3404 (12 lines)

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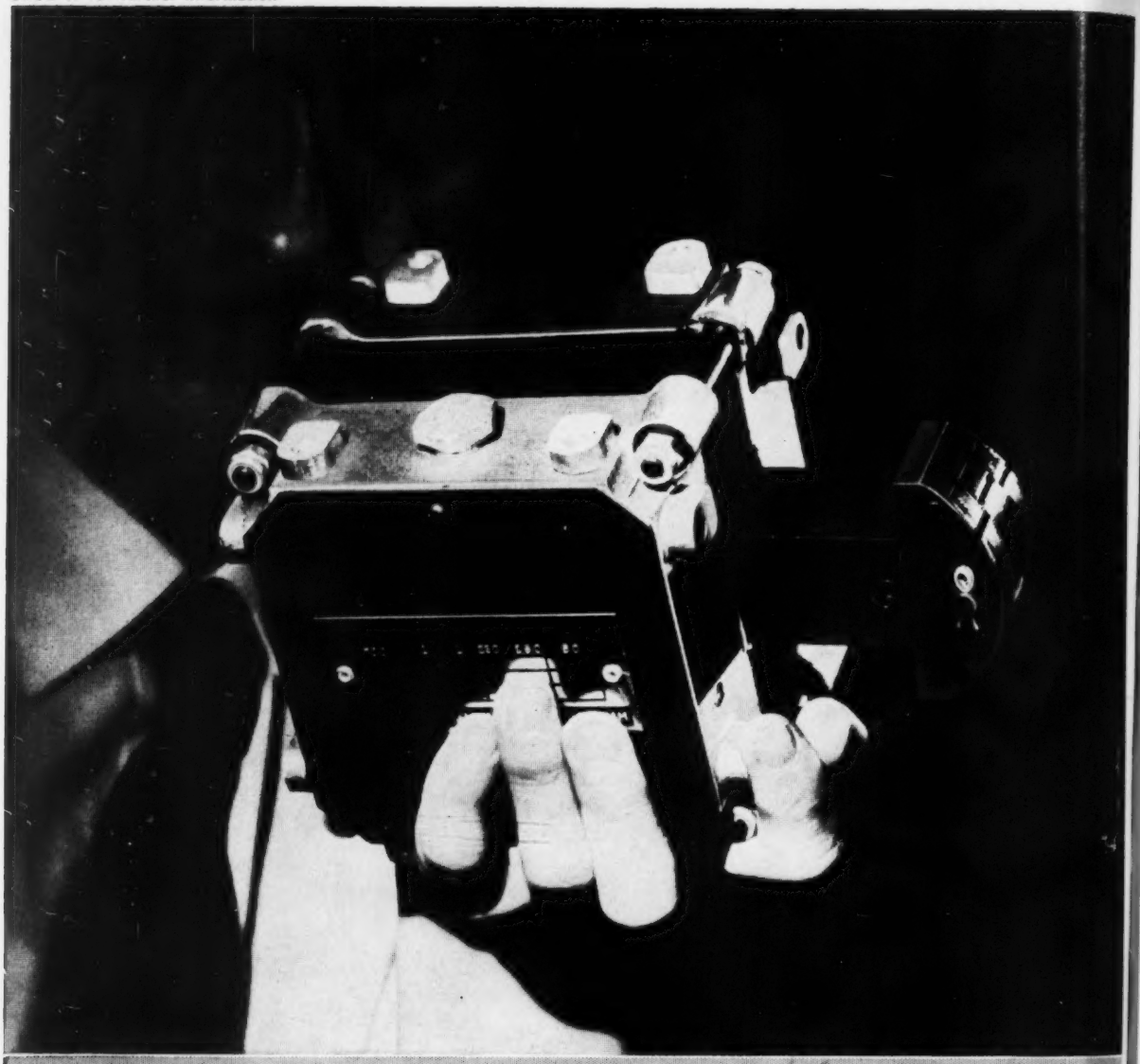
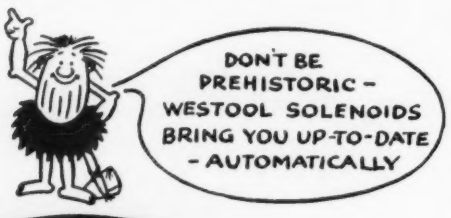
To Sales Department,
AVO LTD., Avocet House, 92-96 Vauxhall Bridge Road, London, S.W.1.

Please send fully illustrated Brochure describing the Model 8 AvoMeter. I.P.

Circle 10 for further information



WESTOOL SOLENOIDS



Westool Solenoids are 'naturals' wherever automatic control is required. Being electrically operated, they can be incorporated easily into any control system whether fully automatic or push-button; being compact, they lend themselves to the streamlined machine layout of today. Their action is instantaneous and certain.

Westool make a wide standard of A.C. and D.C. Solenoids to cover most industrial requirements, and some of these are illustrated here. Practical design, use of the best materials, care in manufacture and thorough testing ensures that Westool Solenoids are the best you can obtain.

For technical data sheets and price list write or telephone today.

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Phone: West Auckland 551/5 **Grams: Solenoid, West Auckland**

Birmingham Office:
7 Newhall St., Birmingham 3
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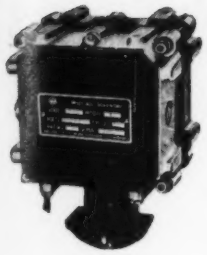
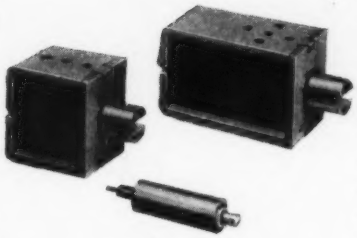
TIB 113

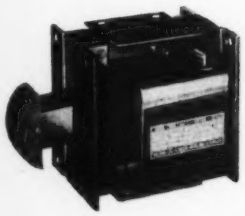


Series 700 A.C.

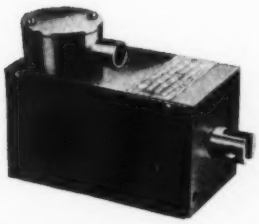


Miniature Solenoids A.C. & D.C. from 225 cm. grammes to 1.5 ozs.

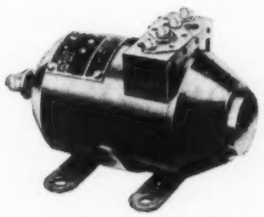
Series 'C', D.C.



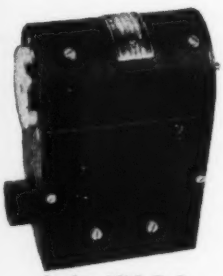
Series 600 A.C.



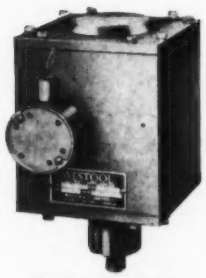
Series 'DK', D.C.



Series 1174 D.C.



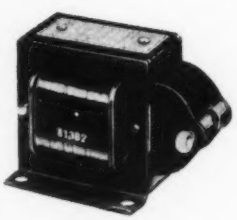
Series 2030 D.C. with rectifier



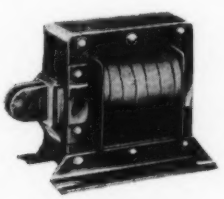
Series 'E', D.C.

Series 'L', D.C.

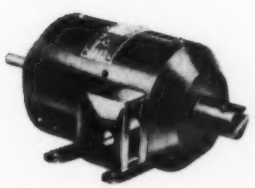
. . . better designed, better made



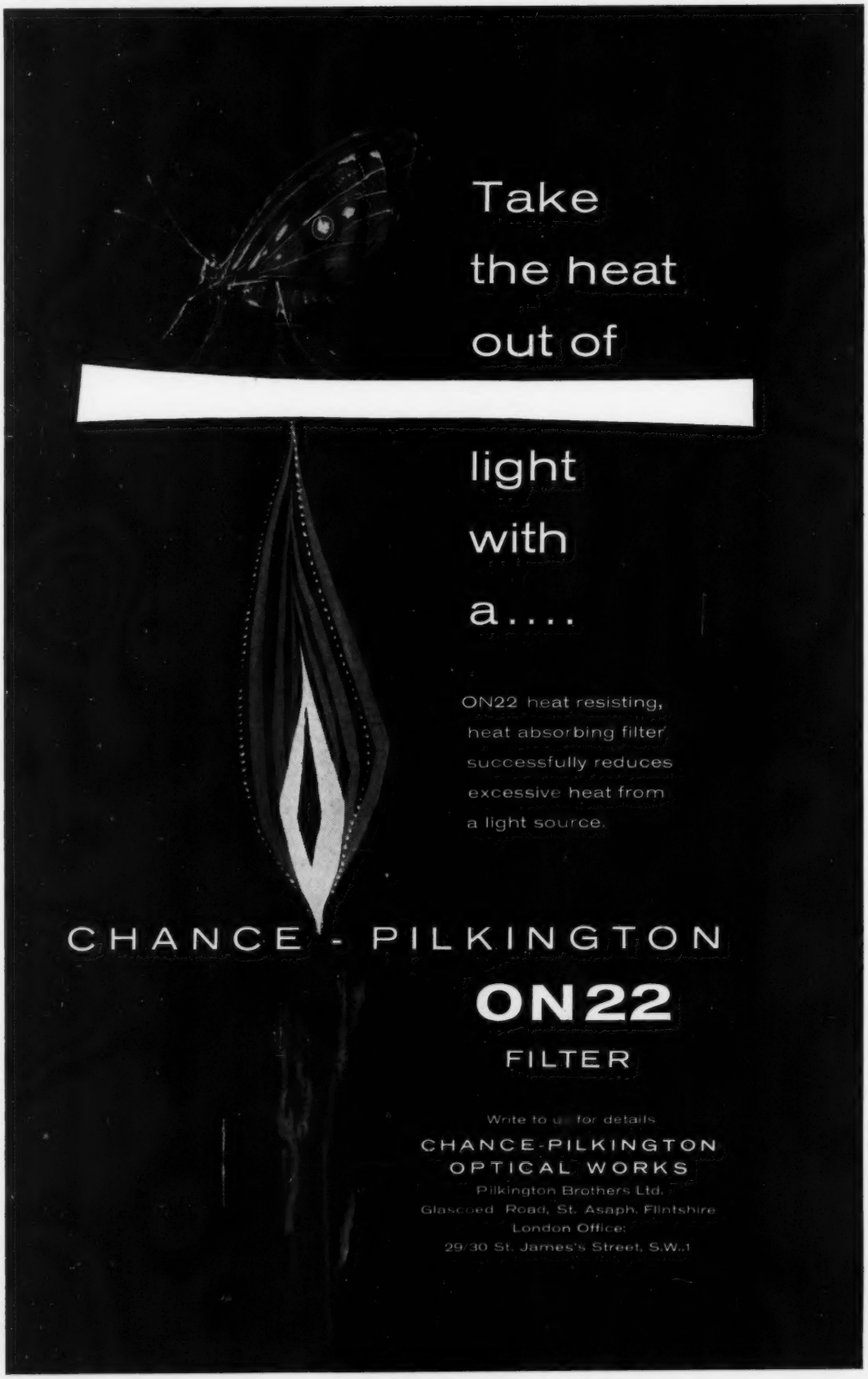
Series 500 A.C.



Series 400 A.C.



Series 2030 D.C.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the heat
out of
light
with
a....
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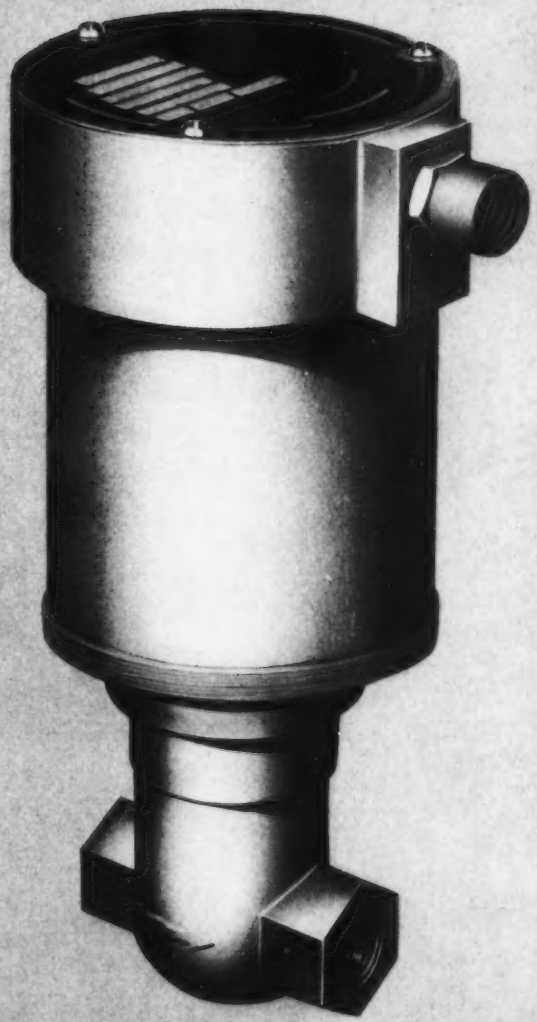
Completely New Range!

ETHER LIMITED

SOLENOID VALVES

— illustrated is one of the HP series high-performance valves for high-viscosity oils



One of an outstanding new range of solenoid valves recently introduced by ETHER LTD., the HP valve is particularly useful for oils of high or low-viscosity. Available in three ranges, each with a different electro-magnetic assembly, ETHER HP valves are also suitable for low and medium-pressure applications with water, air and many other media.

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ETHER LIMITED

Solenoid Valve Division

TEMPERATURE & PROCESS CONTROL EQUIPMENT FOR ALL INDUSTRIES

1959

Circle 13 for further information

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Electrostatic Voltmeters

FOR USE ON A.C. OR D.C. CIRCUITS

FOR VOLTAGES FROM 500 VOLTS— 10 KILOVOLTS

SELF CONTAINED— SWITCHBOARD OR PORTABLE PATTERN

Nalders manufacture a wide range of Electrical Measuring Instruments including **AMMETERS, VOLTMETERS, WATTMETERS, POWER FACTOR METERS, FREQUENCY METERS, SYNCHROSCOPES, PROTECTIVE RELAYS, VECTORMETERS, AUTOMATIC EARTH PROVING SUPPLY SWITCHES, "BIJOU" CIRCUIT BREAKERS, FLAMEPROOF INSTRUMENTS, etc.**

A.S.E.E. EXHIBITION
STAND F12
EARLS COURT 17—21 MARCH

ENQUIRIES WELCOMED

WE CAN MEET YOUR DEMANDS FOR PROMPT DELIVERY

Please write for further details quoting Ref. P3a

NALDER BROS & THOMPSON LTD

DALSTON LANE WORKS, LONDON, E.8

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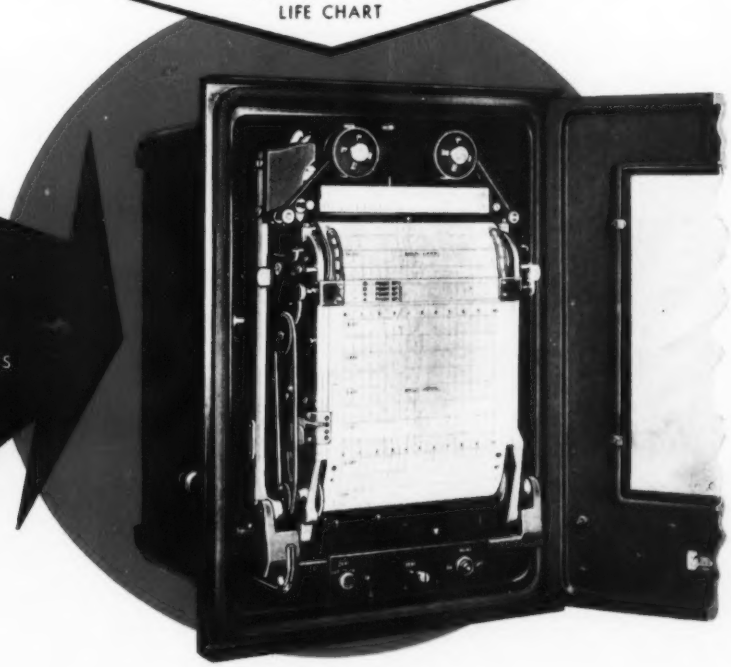
OBTAIN *Automatic* MULTI-POINT RECORDING AND *Accuracy* WITH THE *Bailey* ELECTRONIC SELF-BALANCING STRIP CHART RECORDER

OUTPUT
MULTI-POINT MULTI-COLOUR RECORD ON LONG LIFE CHART

INPUT
THERMO-COUPLES
RESISTANCE ELEMENTS
OR ANY SUITABLE
CURRENT OR
VOLTAGE
SOURCE



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High accuracy and speed of response. ●
Provision for 4 independent records—each colour coded differently. ●
4 chopper-bar operations every 30 seconds. ●
Long-life chart and ink ribbon. ●
Fully sealed oil-immersed servo motor and slide wire. ●
Calibration unaffected by valve replacement. ●
Alarm Contacts available. ●

For Instruments using Thermo-couple Inputs

Transistorised d.c./a.c. converter—no moving parts. ●
Neon stabilized reference voltage—eliminates the need for dry batteries. ●
Automatic cold junction temperature compensation. ●

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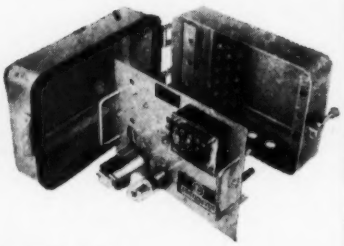
Canute couldn't do it, but we can—been doing it for years now with straightforward electronics!
Elcontrol level controls for solids and fluids are reasonable, reliable, and practically ex stock.

ELCONTROL

Electronic Level Controllers

This standard relay unit embodies a readily withdrawable chassis ideal for installation and easy servicing. A wide variety of probe fittings enables most level control jobs to be effected satisfactorily.



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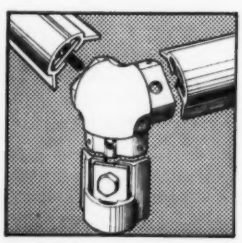
Widney Dorlec RACKING

Widney Dorlec introduce new components for the rapid mounting of standard equipment panels. This economical scheme is fully interchangeable with orthodox equipment and yet avoids the expense of accurately tapped holes.



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SALES OFFICE :
Maidenhead, Berks. (Phone: Maidenhead 4311)

Manufactured by:
HALLAM, SLEIGH & CHESTON LTD.
WIDNEY WORKS · BIRMINGHAM 4 · ENGLAND
Telephone: Aston Cross 0914. Telegrams: Superfine, Birmingham.
WD.29

Circle 17 for further information

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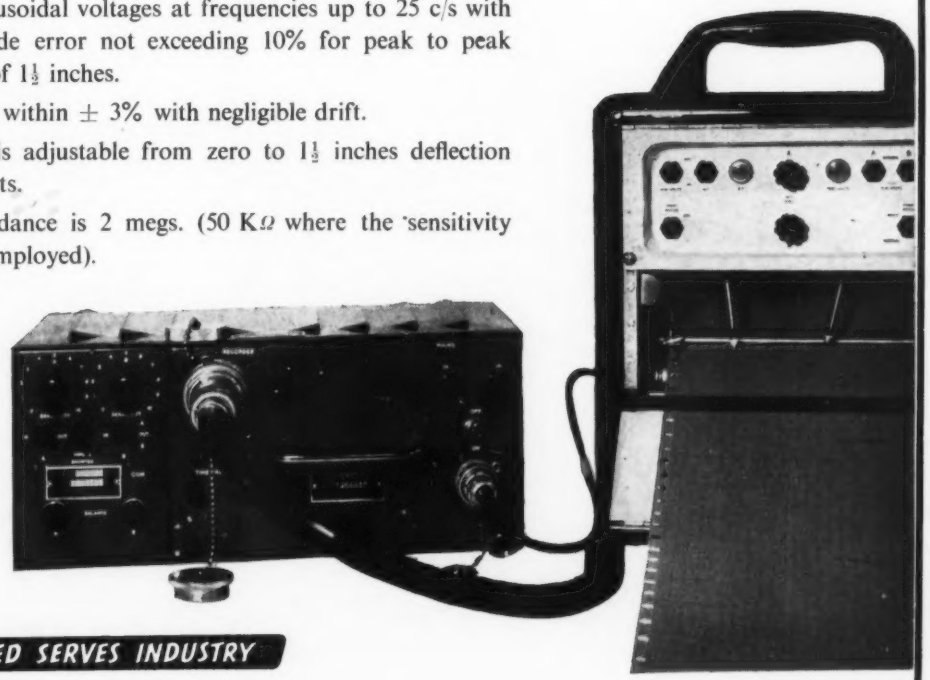

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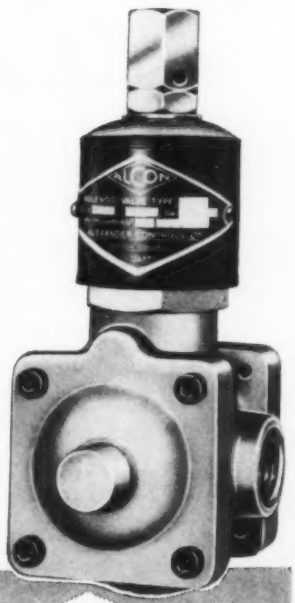

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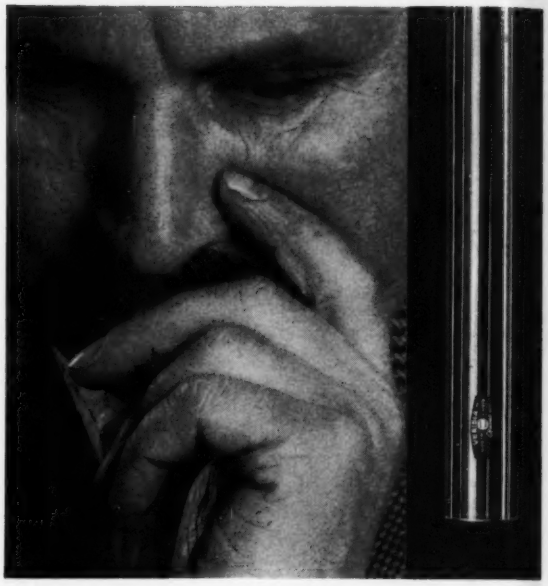

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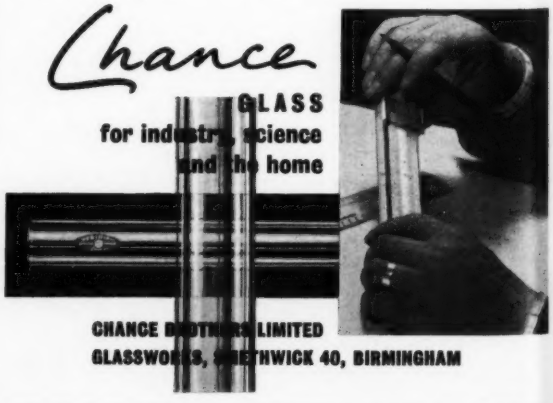

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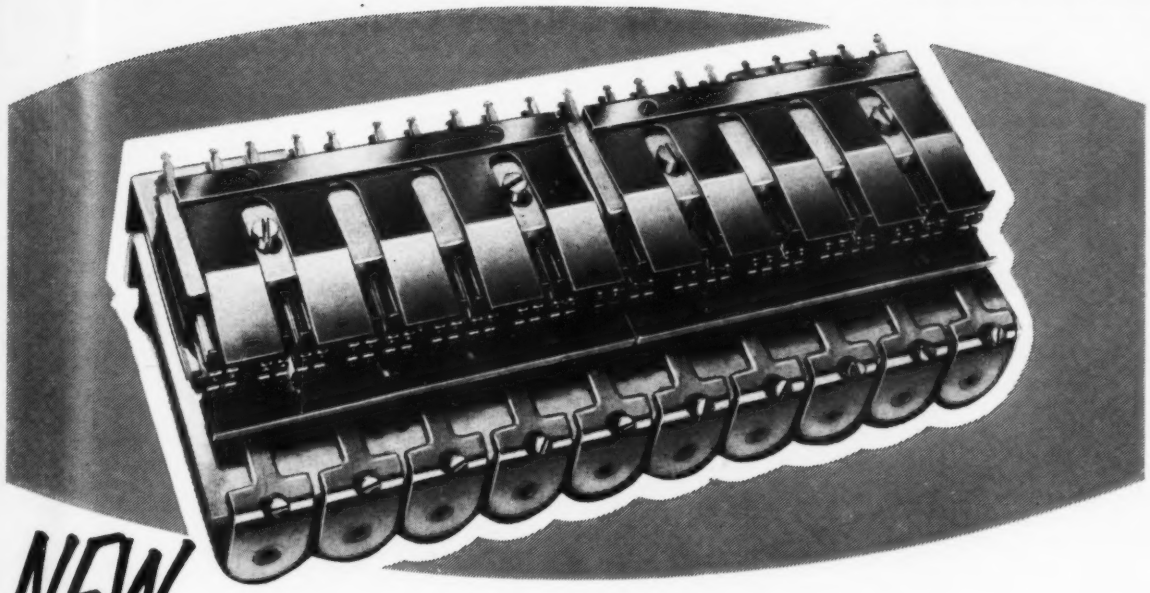

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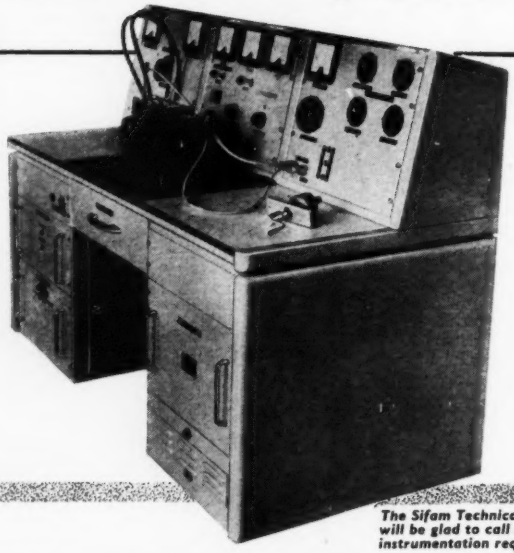

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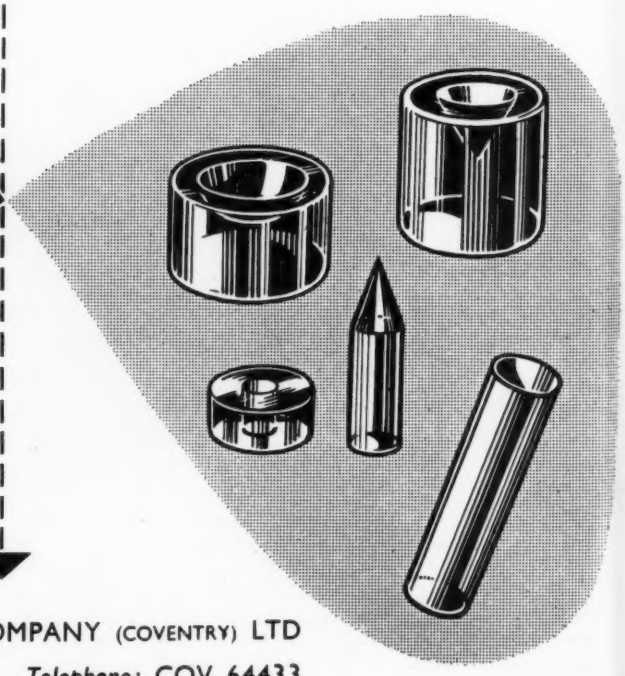

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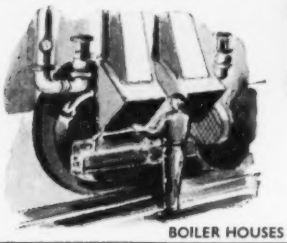

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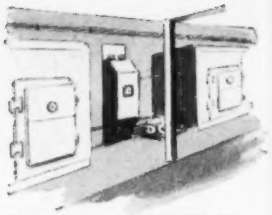

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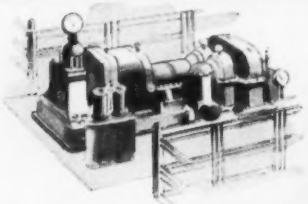

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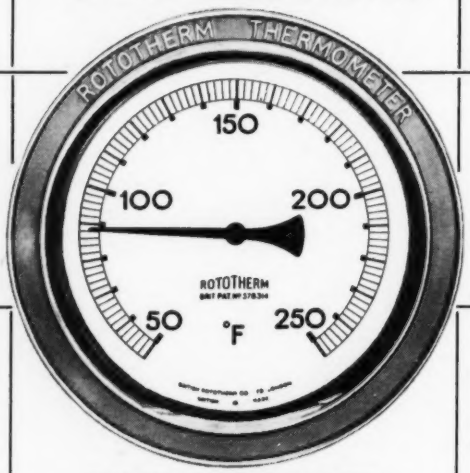

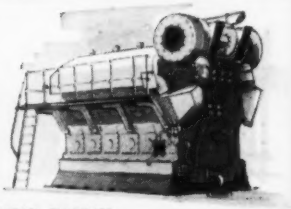

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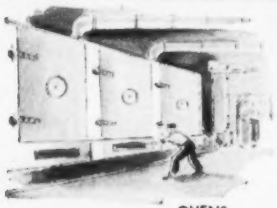

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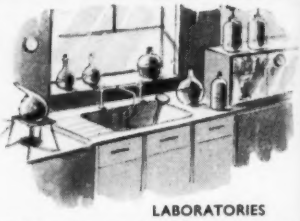

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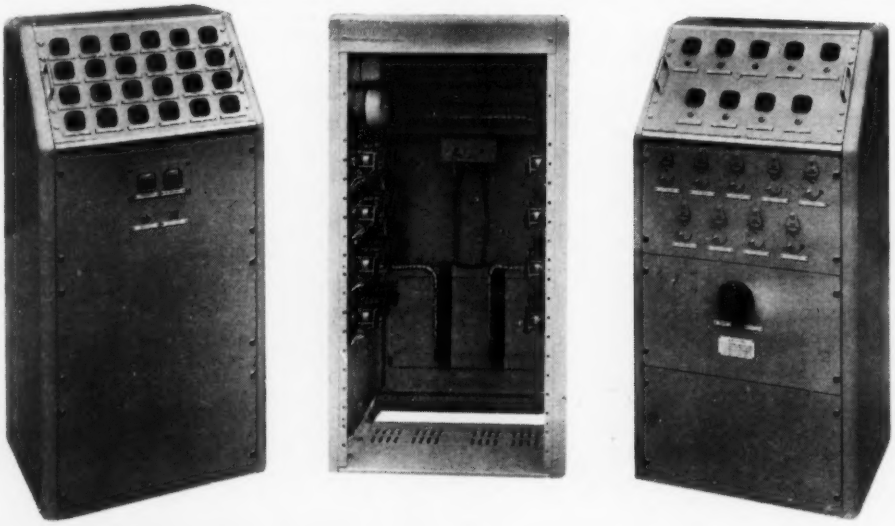

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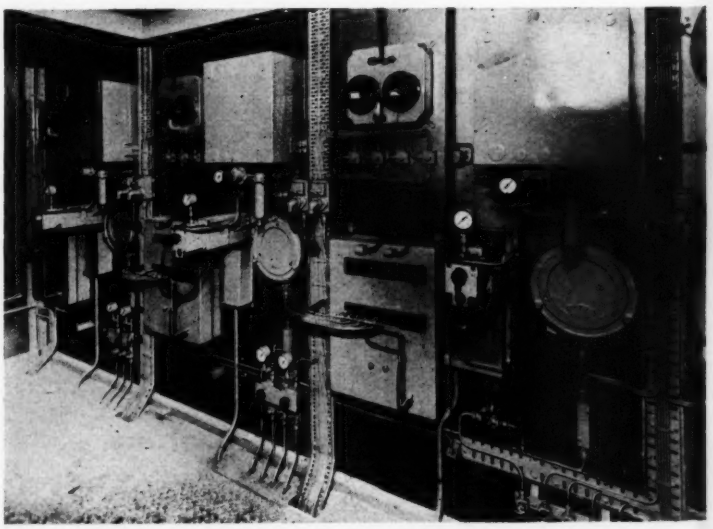

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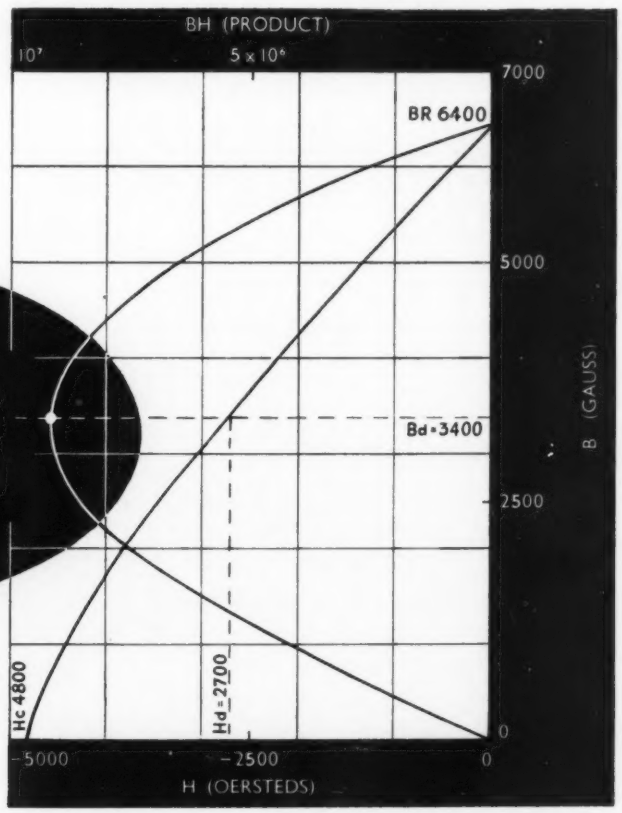

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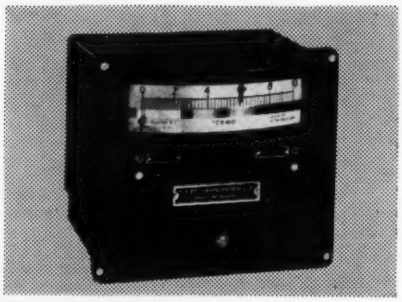

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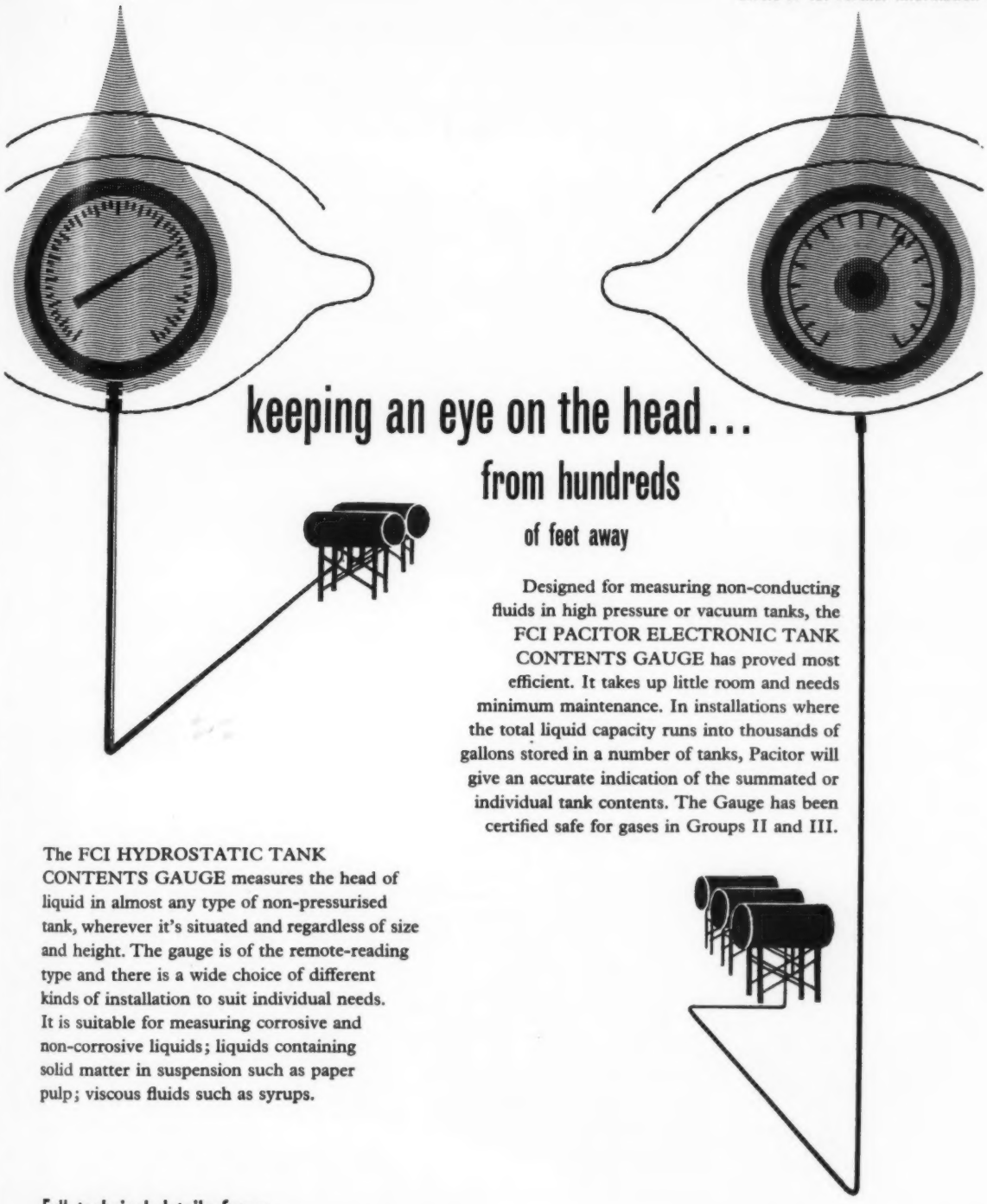

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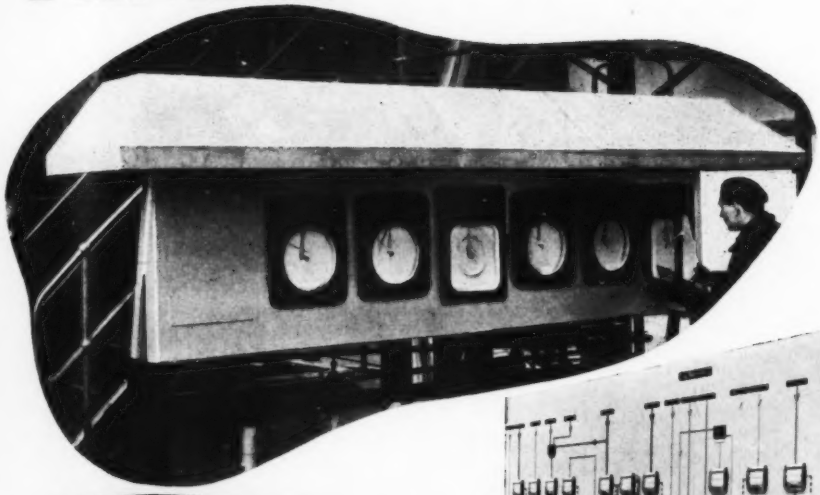

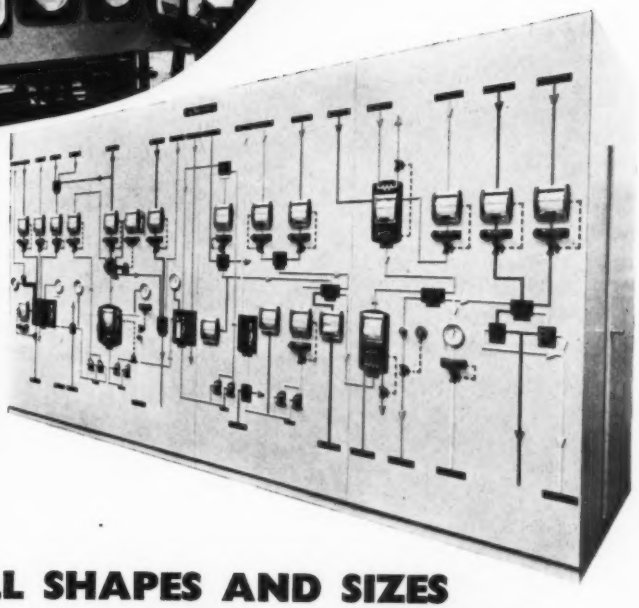

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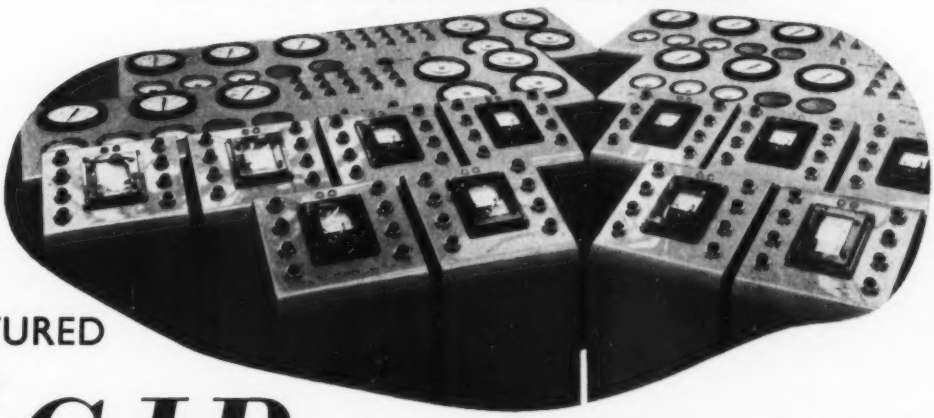

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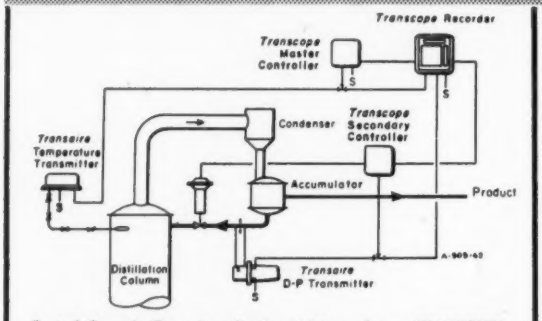

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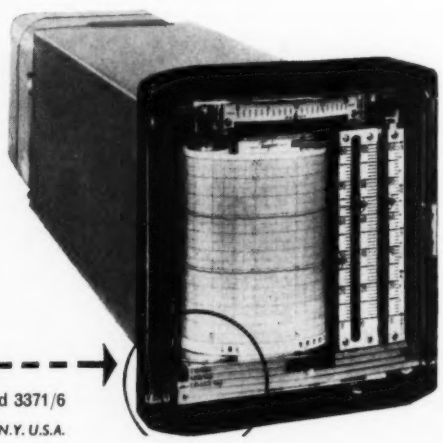

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INSTRUMENT Practice
AUTOMATION & ELECTRONICS

Editor: J. T. Miller, B.Sc., F.Inst.P.

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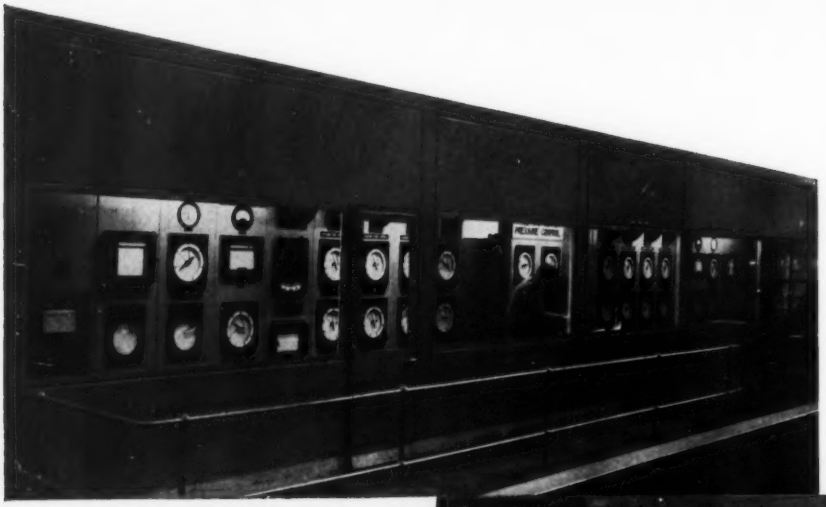

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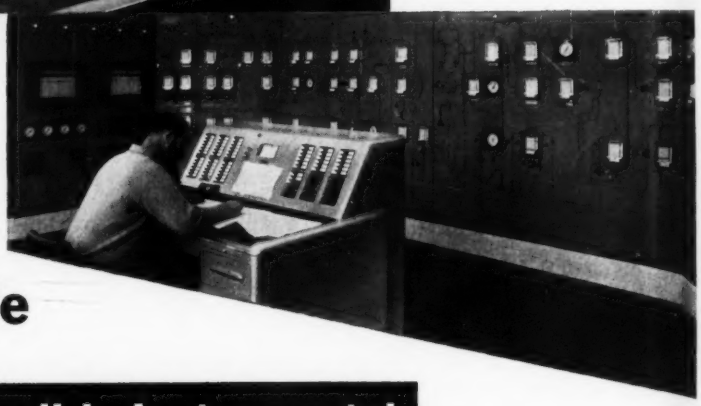

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COMMENTARY

A New Challenge

The recent speech by Mr. Khrushchev, outlining Soviet production plans for the next seven years, contained some statements of policy which ultimately may have profound effects outside his own country and the communist countries generally. The principal reference, in so far as this journal's sphere of interest is concerned, is to automation. It seems fairly clear that the Soviet leader is aiming to present Russia with both "guns and butter".

In other words, he proposes to carry out a full armament programme and raise the standard of living at the same time. Amongst other benefits a 35-hour week is mentioned. The speech will be familiar to all readers since it was widely publicised and there is no need to repeat sections of it here. A failure to fulfil the intentions announced will certainly not be tolerated by the Soviet leader, and one can therefore envisage the plan coming to a successful conclusion. Obviously Soviet industry must increase its production enormously and to effect this automation will be further developed and applied on a large scale. One includes here education and training at all levels, pure research, development and plant design. There is in Moscow an "Institute for Automation and Electromechanics" and there is also a Ministry of Automation, giving some indication of the seriousness with which the Russians regard the subject.

Assuming ultimately that the Russians achieve not only sufficiency within their own borders, but have a surplus of goods to export, it is fairly easy to see where the trading would take place. China has 500 millions of people and India 350 millions. *Cheap* mass produced goods, not necessarily of low quality, could find a ready sale here. The first-named country has been well considered as a possible future expanding market for the United Kingdom.

Three or four years ago in Great Britain there was a sudden surge of publicity given to the subject. After the surge had died away, much permanent interest remained. Three new specialist journals, additional to those already existing, have been introduced in the period stated. An increased number of courses dealing with automatic control have been instituted at colleges and universities. Developments have been carried out by private firms and government departments. Some industries are automated to the fullest extent. One thinks of the motor car factories here and a very recent example is the Vauxhall Motor Co.'s works at Luton described in recent articles in this journal. Then today we have the heavy chemical industries in which automatic control is widely applied. A relatively recent event, indicating awareness of the importance of the field, was the formation of the British Conference on Automation and Computation, whose aims are to foster progress in all aspects of automation. Will, skill at all levels, and enthusiasm are present no less than in Russia, but the *rate* of progress remains an open question.

Mr. Leon Bagrit, vice-chairman of Elliott-Automation Ltd., in a recent article (*Observer*, 1st February) after a visit to Russia, drew attention to the need for a national policy particularly regarding the introduction of new equipment, education and so on. Whilst, of course, we in this country like to solve problems without recourse to Governmental direction, it would appear that State interest in automation has been subjugated to guided missiles, nucleonic energy applications (in both forms) and the like, and it is not encouraging to see a very prominent manufacturer of automation equipment announcing redundancy of some hundreds of workpeople.

We have another quite serious problem to solve and that is the position created by the European Customs Union. No effective compromise seems to be in sight and competition is bound to be severe. Whether or not automation will alleviate any ill effects from this source must be a conjecture. But at least it could be examined. "Time is on our side." This is a phrase used in the past. That condition has gone forever from this country. Time will never be on our side again in whatever sphere of activity we are engaged. Those of us engaged in scientific or engineering vocations, whatever our political views, do not, nor have we regarded, the Russians as a mass of illiterate peasants and bunglers. Governmental sources have sometimes been suspect from this angle and it could be that some trace still remains. If these high levels can realise that here is a skilful, powerful race of people engaged in a ruthless drive for better things and prepared to utilise the maximum amount of instrumentation, automation (call it what you will) to achieve it, it would be a vast encouragement, at least, to the automation industry.

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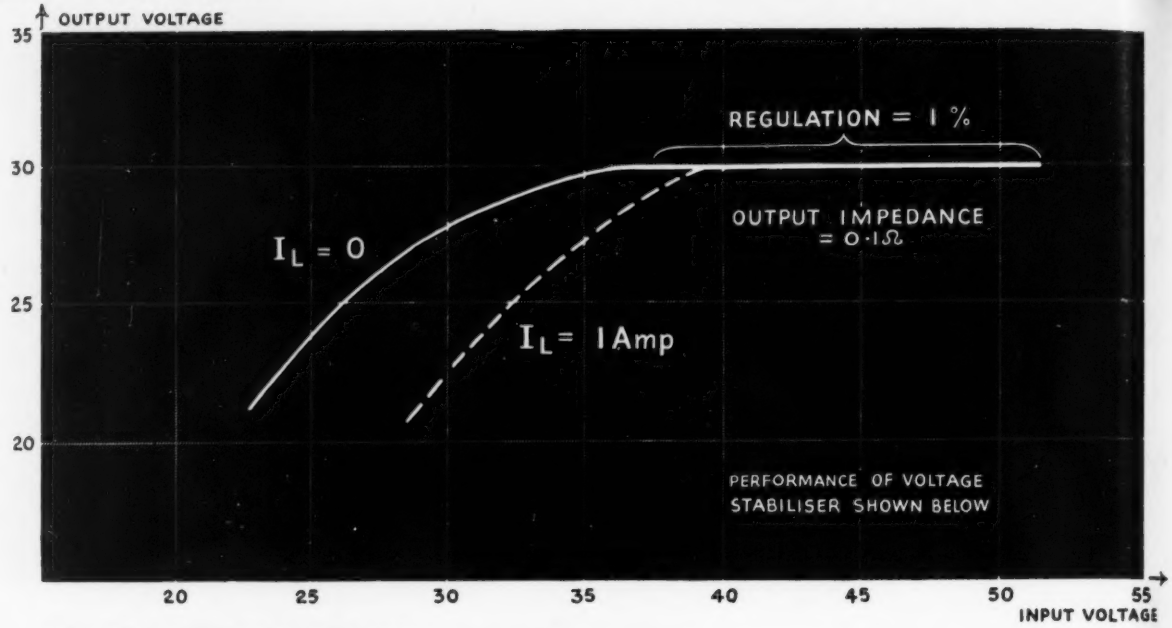

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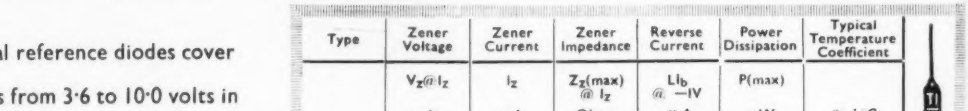

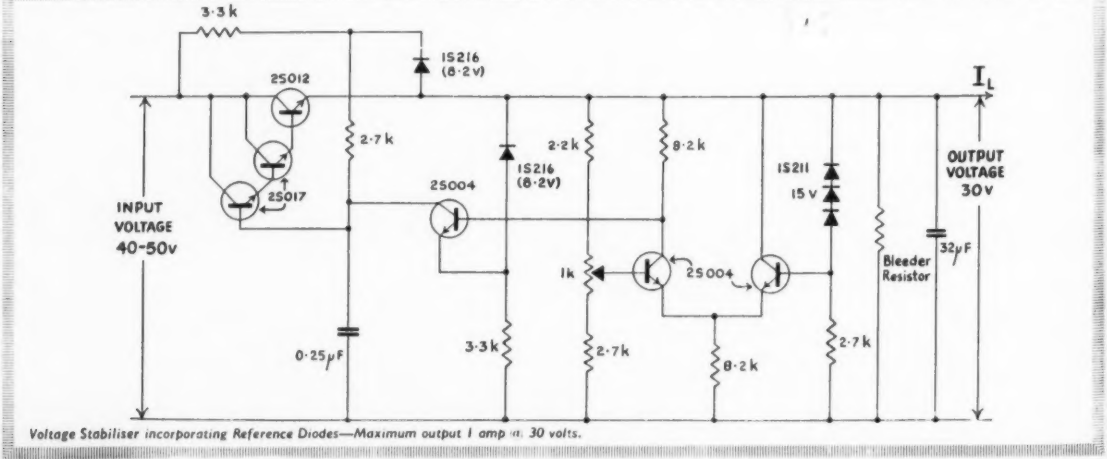

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T27A

AN OPTICAL TECHNIQUE FOR CONTINUOUS MEASUREMENT OF THE WIDTH OF NARROW HOT ROLLED STRIP

By C. Burns, B.Sc.

and J. W. Stevens*

A novel optical technique has been developed for the requirements of continuous width measurement of narrow hot rolled strip. An experimental instrument using this principle is described. Works trials indicated an accuracy of ±0·005 in. with a response speed of 0·1 sec, irrespective of considerable transverse shake of the moving strip. Air purging arrangements enable the instrument to operate in the face of continual heavy air pollution by scale dust from the strip.

INTRODUCTION

An accurate method of measuring the width of hot rolled material is needed. Methods now used are of very limited accuracy and cannot provide a continuous measurement of width along the length of a strip. An accurate and rapid method of measuring strip as it is rolled would obviously allow much closer control of the process.

Continuous width measurement is especially necessary on strips used for making welded steel tube. The strip is folded into a circular section and the seam welded. Strip narrower than the permitted tolerance will give an open or unsatisfactory welded seam; over width may cause malformation of the tube, or excessive strains in the tube forming machine.

The difficulties of performing this measurement, on the other hand, are considerable. The strip issues from the mill at a speed of several hundred feet per minute and close constraint of the moving material other than at the rolls is undesirable. As contact methods of measurement are to be avoided if possible, optical methods offer the greatest promise of achieving the desired accuracy. The instrument must be unaffected by the rapid movement of strip, its lateral shake, and its high temperature (about 900°C) and must also work in an atmosphere heavily polluted by the clouds of scale dust rising from the strip. The instrument described was developed for use on a Morgan mill producing strip for welded tube manufacture[1].

PRINCIPLE OF THE WIDTH-METER

Optical methods offer two main lines of approach:—

(1) Detection of position of each edge, and subsequent summation to indicate the total width of the strip.
(2) Use of the strip to interrupt a beam, the residual width of the optical beam being an inverse measure of the width of the strip.

The first method has been developed for applications where the strip is wide and its movement slow[2]. Where the strip moves fast, with rapid lateral shake, it is less suitable since the response speed must be high enough to follow the movement of individual edges although the variation in width may be much slower. The second method does not suffer from this limitation, since the width of the residual beam, the quantity actually measured, is independent of the lateral shake of the strip and the response speed of the instrument is required to deal only with changes in the strip width.

Fig. 1(a) illustrates the basis of this method. The strip, width W, partially obstructs a uniform beam of rectangular cross-section. The width of the beam D, transverse to the length of the strip, must be large enough to accommodate the width of the strip plus the maximum shake (±s) and its maximum range of width variation (R). This can be expressed as $D = W + R + 2s$ (if W is taken as a minimum figure). In practice the width of D must also allow for any edge effects which cause the beam to depart from the theoretical ideal of uniform illumination through its cross-section. As in fact no shadow is perfectly sharp, this factor must be allowed for in the detail design, but is neglected in this elementary assessment.

The portion of the beam obstructed by the central part of the strip will, in fact, never be uncovered if R and s are small compared with W (as was the case in the application considered). The beam of width D can, therefore, be replaced by two small beams of minimum width $= 2s + R/2$. This, it should be noted, is their initial width. In the presence of the strip, their final aggregate width will vary between 2s and $2s + R$. Since the quantity being directly measured is the total light transmitted, the mean proportional change in the quantity actually measured for an increment in strip width δW is therefore $\dfrac{\delta W}{2s + R/2}$.

This method was not used as described but was further elaborated, to increase the potential accuracy of the system, in the manner illustrated in Fig. 1(b), (c).

Fig. 1(a) shows dotted the two smaller beams, width $2s + R/2$, which are all that are required from the large beam, width D. If one beam is made to combine the functions of both these beams, by reflecting it to pass the strip a second time in the reverse direction, it can be bounded top and bottom by the shadows

* Physics Department, The British Iron and Steel Research Association.

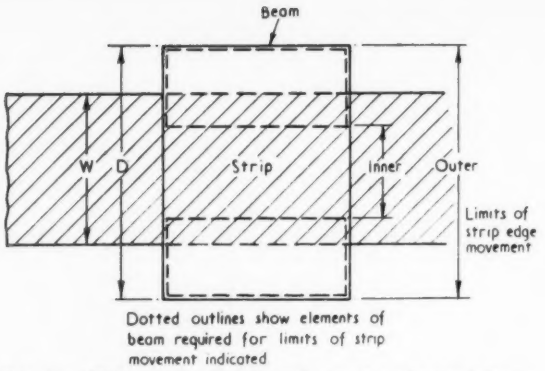


Fig. 1a. *Width measured from obstruction of a single beam.*

of the two strip edges, and its residual width will be a measure of the strip width. Moreover, its maximum width need not exceed R (neglecting edge effects) so the proportional change in light measured for a width change δW is now at least $\delta W/R$, a factorial increase over the previous method of $\frac{2s + R/2}{R}$ or approximately $2s/R$ if s is larger than R, as usually occurs.

Since in the application considered, 2s might be as much as $\frac{1}{2}$ to 1 in., and R was intended to lie between 0·05 and 0·1 in., a considerable increase in potential accuracy is possible by using the "reflexed" beam arrangement, which forms the basis of a patent covering the instrument.

GENERAL LAYOUT

The practical advantages of this layout are also considerable, as can be seen in the general diagram of Fig. 2. Except for two prisms and their air purging arrangements, all the operating parts of the instrument can be concentrated in one box, located on the most accessible side of the strip guide. The instrument was placed over the trough-shaped guide which conducted the strip, in a vertical position travelling on one edge, from the last rolling stand to the wobbler rolls which ejected the strip on to an apron (Fig. 3). The two boxes, the main box and the prism box, are mounted below a girder to form an inverted "U" shaped framework. The girder is sufficiently deep to give the high measure of rigidity required, for the beam, passing from

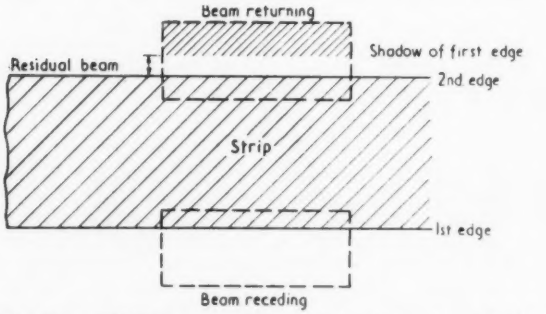


Fig. 1b. *Width measured from obstruction of a reflexed beam.*

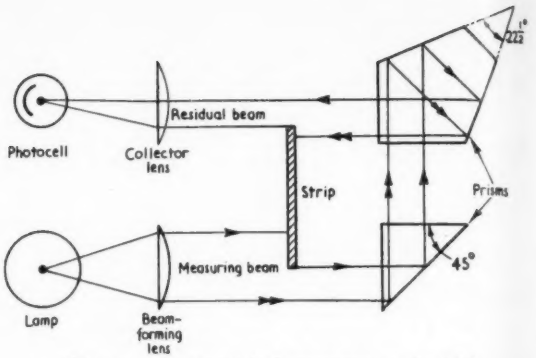


Fig. 1c. *Basic optical arrangement for* 1(b).

one box to the other and back, is sensitive to relative movement between them.

Since the strip is at a high temperature, water-cooled plates are placed above and on each side of the guide to shield the instrument from the heat, with suitable apertures to allow the light beams to pass through.

DETAILS OF OPERATION

To render the instrument independent of variations in lamp brightness and in the gain of its electronic amplifier, the light flux carried by the measuring beam is balanced against a comparison beam, also coming from the lamp. This is effected automatically by a spiral shutter in the path of the comparison beam, rotated by the output of the electronic amplifier.

As shown in the schematic diagram, Fig. 2, light is supplied by a single d.c. "Pointolite" lamp. Two condenser lens systems form images of the lamp filament (a small incandescent sphere) on two slits, which are alternately covered and uncovered by a toothed chopper disc. The slits are at the focal points of the two beam-forming lenses, which produce the parallel beams used for measurement and comparison. The measuring beam goes round three sides of a rectangle as described above; the use of one right-angle and one pentagonal prism (i.e., of three reflections) means that the opposite edges of the strip cut into opposite sides of the measuring beam.

(Photograph by courtesy of Messrs. Stewarts-Lloyds and J. Iron and Steel Inst.)

Fig. 3. *Instrument on site.*

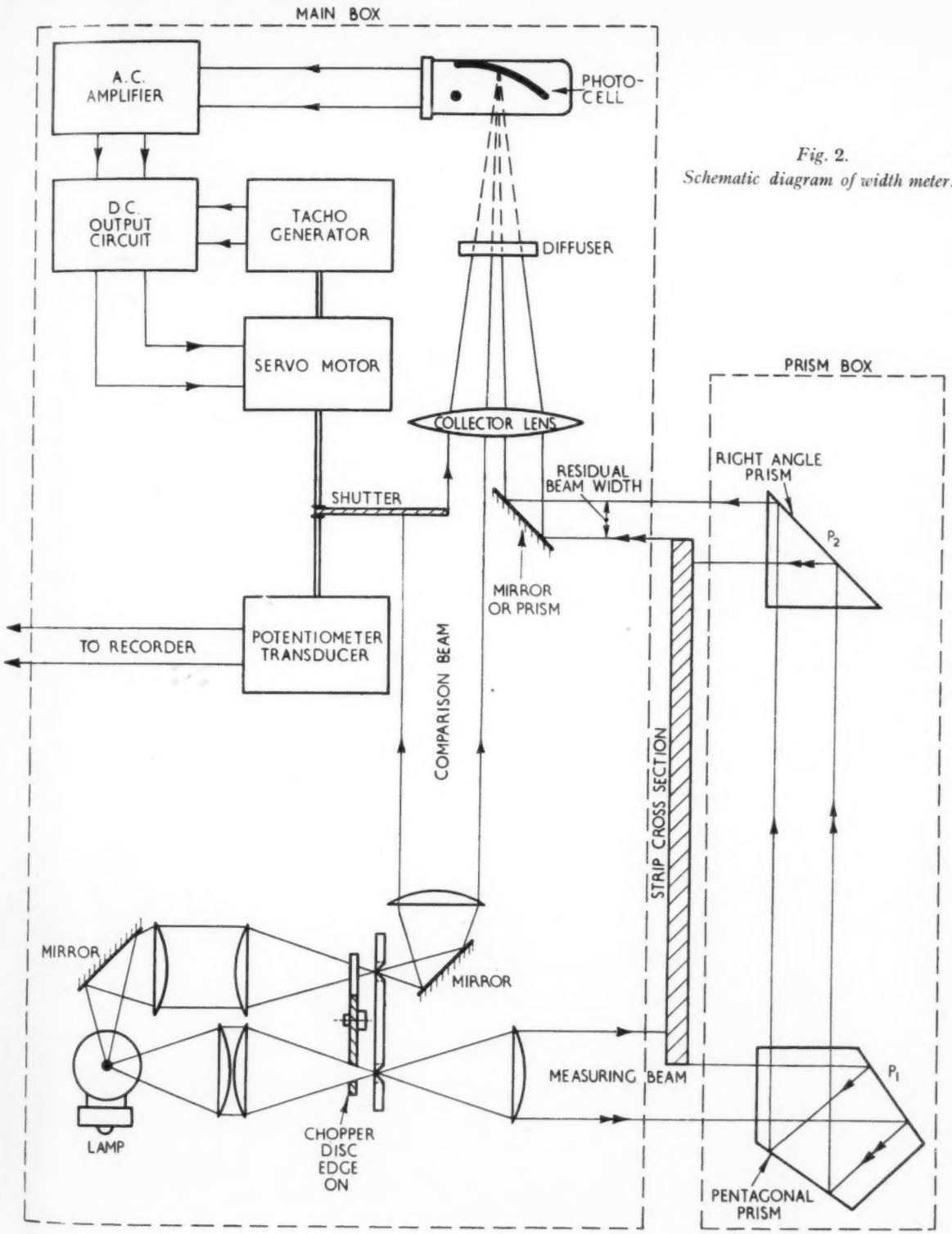


Fig. 2.
Schematic diagram of width meter.

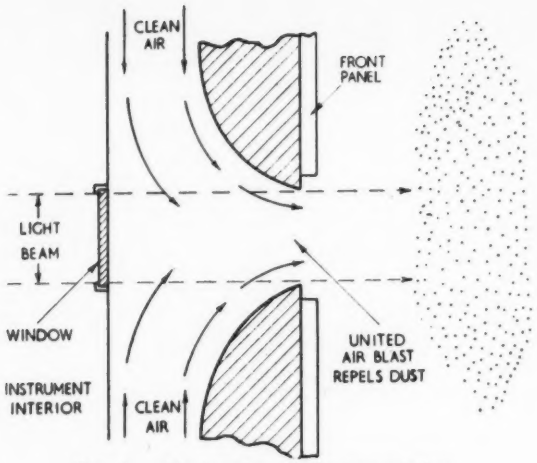


Fig. 4. Air purging cell for one window.

On re-entering the main box the measuring beam is reflected to travel parallel to the comparison beam, after the latter has passed by its shutter. Both beams fall on a "collector" lens, which brings the light to a focus (or, more correctly, to two coincident foci) on the photo-cell cathode. A diffusing screen is interposed in normal operation, however, to spread the light over the photo-cathode surface.

Since the beams are "chopped" the signal from the photo-cell will be steady when the beams are balanced and alternating if they are not. The a.c. component of the signal is amplified, rectified and fed to a balanced output stage which drives the servo-motor in the correct sense, actuating the comparison beam shutter to restore balance between the beams.

A potentiometer transducer is also coupled to the shutter spindle, producing a direct current proportional to the shutter position. This current can be displayed on a suitable high-speed chart recorder.

PERFORMANCE

In the laboratory, the instrument could measure to an accuracy considerably better than the standard of ±0·005 in. aimed at. (It was in fact possible to detect on the recorder trace the passage of a hair, diameter 0·002 in., through the measuring beam.) The range of width variation usually measured was ±0·125 in., with a permissible shake of the strip of ±0·25 in. These two quantities are interchangeable, their sum being equal to the width of the useful portion of the measuring beam where the light distribution is uniform across the direction of the width measurement.

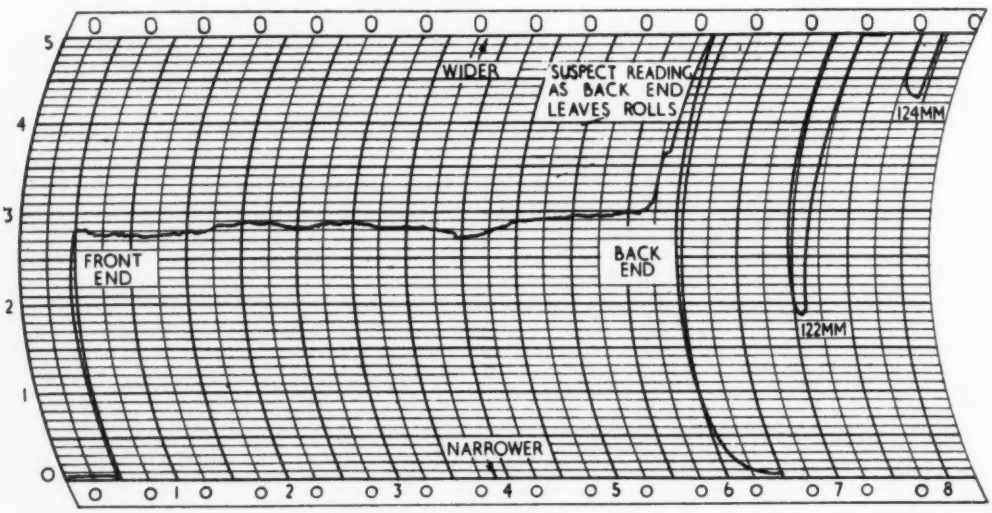
It should be emphasised that these figures do not necessarily express any fundamental limitations of the instrument. The optical system is capable of being recast to deal with the different requirements of particular applications.

PROTECTION OF WINDOWS

The cloud of scale dust rising from the hot strip makes it essential that none of the dirty air surrounding the instrument should be allowed to reach the windows, which were protected in the way shown in Fig. 4. In the experimental instrument designed to deal with one width of strip only, the two duct systems belonging to each box were built into a single flat-sided unit, the blast from a single blower being split by a "distribution box" to supply each window's air purging cell. For an instrument dealing with a variety of widths the cells could be made independent and fed by flexible hoses.

The input to the blowers was drawn from a clean air main. The protection provided in this way was very effective. Runs of up to 24 hours on the mill produced errors of less than 0·01 in. in reading. (A change greater than this was caused by dust settling on the windows when the instrument was left standing with the blowers off, in relatively clean and protected surroundings, for a comparable period of time.) Circumstances did not permit of runs much longer than 24 hours, so it was impossible to test the air purging more exhaustively.

Fig. 5. Recorder trace for a single strip, and calibration strips, fast speed.



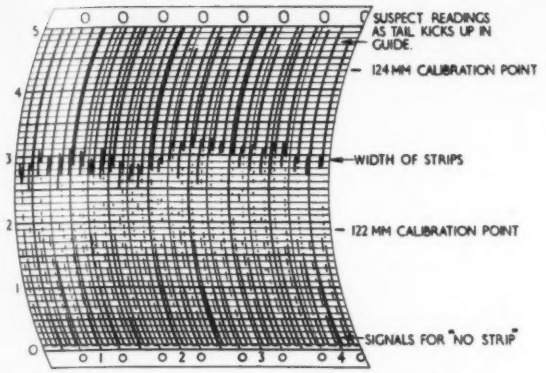

SUSPECT READINGS AS TAIL KICKS UP IN GUIDE
124 MM CALIBRATION POINT
WIDTH OF STRIPS
122 MM CALIBRATION POINT
SIGNALS FOR "NO STRIP"

Fig. 6. Excerpt from an all-night run recorded at slow speed.

The small drift quoted may be caused by traces of dust in the air supply to the blowers, or in the air inside the instrument boxes, rather than by scale dust penetrating from outside.

RESULTS OF TRIALS

The instrument was tested in the mill in the site described, while the appropriate width was being rolled. Recordings such as are illustrated in Figs. 5 and 6 were obtained. By a choice of recorder speeds it was possible to obtain either a detailed record of the width variations over the length of a single strip (Fig. 5) or a compact record of the variations between strip and strip over a prolonged period (Fig. 6).

The accuracy of the record was checked by setting aside sample strips which had been measured by the width-meter for subsequent cold micrometer readings. When due allowance was made for contraction as the strip cooled, correlation between the two measurements was very good. Certain anomalies found at first were due to very gross fluctuations in the d.c. main supply, utilised for the "Pointolite" lamp, and were cured by the provision of a stabilised supply. Fig. 7 shows a sample strip where the two measurements agree to an average of $\pm 0{\cdot}0025$ in. An interesting feature disclosed by such measurements was the "family resemblance" between successive strips. This was ascribed to uneven heating along the length of the billet in the re-heating furnace.

In operation the instrument was checked by calibration strips passed through the measuring beams. Two such strips of widths 122 and 124 mm established the slope of the straight-line calibration curve for interpreting the recorder traces. In the experimental instrument certain mechanical refinements were omitted, in the control of "sensitivity" and "zero" by optical means in the comparison beam, to simplify such modifications as experiment might indicate were necessary. In a production instrument, these would allow the chart calibration of width per division to be chosen, and the nominal value of width to be placed in the centre of the chart.

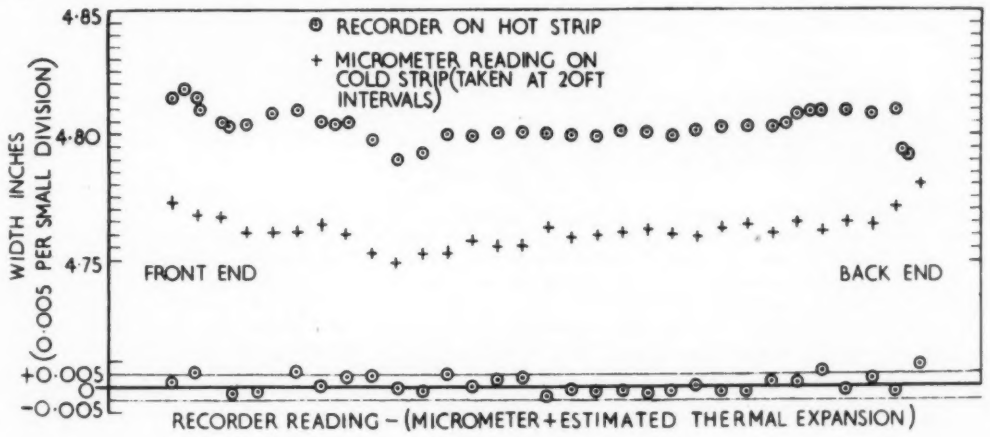
LIMITATIONS OF THE MEASURING TECHNIQUE

It has been mentioned above that the instrument is suitable for the narrower sizes of strip. This arises from the fact that since the light source must have a finite size, the shadow cast by an edge cutting into the parallel beam must have a penumbra, which will grow wider along the length of the beam path, curtailing more and more the width over which the beam is uniformly illuminated.

Fig. 8 shows the geometry of the measuring beam when the size of the penumbra is taken into account. The reflections have for simplicity been omitted. The light source is the slit S_1S_2, subtending an angle α at the beam-forming lens L_1L_2. This will also be the angular width of the penumbra of the beam edges and of the shadow of the strip edges E_1 and E_2, entering the beam. The inner edges of the penumbra L_1P_1 and L_2P_2 enclose the portion of the beam where the illumination is uniform across its width. E_2P_1' represents the permissible increase in strip width. The permissible shake is $\pm\frac{1}{2}(E_1P_1 + E_2P_2)$ about the central position (i.e., when $E_1P_1 = E_2P_2$).

Operation can be maintained over longer path lengths by cutting down the size of the slit S_1S_2, which narrows the penumbra. This, however, causes a proportionate decrease in the change in light flux per unit change of strip width, reducing the sensitivity of the photo-

Fig. 7. Comparison of sample strip measurements from width-meter chart and from cold micrometering.



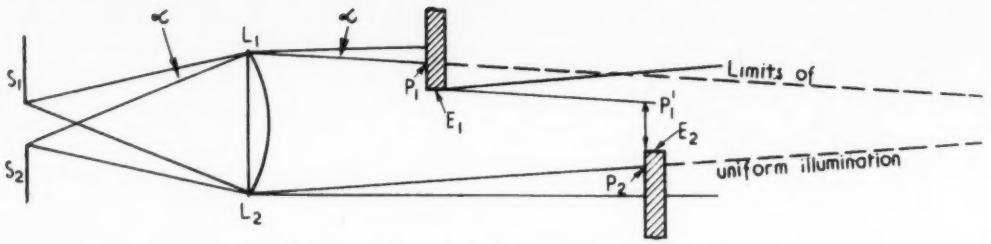


Fig. 8. Effect of slit size on measuring beam.

electric system. No exact figures can be given of the limitations this factor imposes on performance, since it is closely bound up with the intrinsic brightness of the light sources available, and also on the sensitivity of the photo-electric detector element. In the experimental instrument, the total path length between edges is approximately 24 in. As the strip itself is under 5 in. wide, the width must be increased by a factor of 2 to 3 before the effect is serious. This fact, combined with the sensitivity which the instrument possesses in excess of performance requirements, leads to the rough estimate quoted of 18 in. for the upper limit of width measured. This is no doubt capable of being improved by further development.

CONCLUSIONS

The optical technique developed offers a solution to the problem of non-contact measurement of the width of a rapidly moving extended object within certain imits of size. An experimental instrument has been made to operate on rolled steel strip at a high temperature, and amidst heavy atmospheric pollution. The principle is equally applicable to cold specimens, when many of the difficulties, not fundamental to the optical problem, will be absent.

The development of an industrial instrument using this technique for width measurement of hot rolled strip is now being undertaken by a British firm.

ACKNOWLEDGMENTS

The authors acknowledge gratefully their debt to Messrs. Stewarts and Lloyds Ltd., who assisted in the making of the experimental instrument and co-operated in an extensive series of trials, and to all members of B.I.S.R.A. staff who have assisted in this project.

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2. A width-meter for hot steel strip. C. BURNS & B. O. SMITH, *J. Iron and Steel Inst.*, **186,** June, 1956, pp. 218-223.

Company Activities during 1958

British Thomson-Houston Co. Ltd.

Development of control gear during the year has been mainly concentrated on the consolidation of recent designs, but there are a number of new items, some of which are mentioned below.

Two sizes of a new line of a.c. crane protective panels are now in production, rated at 75 and 100 amp respectively, and consisting of a line contactor and up to twelve overload relays with optional isolating switch.

New auxiliary switches for use on standard contactors and relays have been developed in two forms, Type TR, up to 1 amp for use on a new 50 amp single-pole d.c. unit contactor, and Type TQ as a general purpose auxiliary switch. The Type TQ with either two, three, four or six contacts may be arranged with any combination of normally-open or normally-closed contacts, and the contacts may also be arranged to give early make or break, or have an overlap feature. The contacts normally handle control circuits, but they can, however, be fitted with a magnetic blow-out to give increased performance.

Wire-wound resistors Type GP are being used in combination with standard Type RQ grid resistances to give greater flexibility on smaller horsepower ratings.

The present range of standard unit a.c. contactors has now been extended from 300 amp up to 450 amp.

The Electronics Group are responsible for the development and manufacture of the rod control system for Berkeley Nuclear Power Station.

During the past year extensive tests have been carried out on critical components and complete prototype actuators. These tests were devised to simulate the adverse conditions within the reactor pressure vessel, and include a pressurised high-temperature endurance test rig which is still being run to find the ultimate mode of failure.

In the field of electronic instruments, manufacture has continued on standard lines such as leak detectors, infra-red radiation pyrometers, gaussmeters, and the

various types of vibration measuring equipments. In addition a number of new developments have been completed.

An amplifier has been designed for use in an experimental installation of a smoke monitor installed in a power station of the C.E.G.B. In this equipment the smoke particles are charged by passing through a region of corona and the number of particles is assessed by measuring the current collected when they are subsequently discharged. The basic work on this equipment was done by the BTH Research Laboratory, and the Electronics Group were responsible for the amplifier which handles the small discharge current of 10^{-9} amp. The model has worked satisfactorily in extremely dirty conditions for thousands of hours.

The crane approach warning system is designed to give warning of the proximity of any object on the crane track, such as another crane, stop blocks, or even a man working on the track. A trials installation was made at the works of Richard Thomas & Baldwins Ltd., Scunthorpe; performance proved satisfactory even when the equipment was subjected to extreme voltage surges on the mains supply. Production is now proceeding and a considerable number of orders have been received. Further development is in hand.

Experiments have been carried out on the remote control of groups of motors (such as those of a crane) from a fixed point, using a single pair of conductors and transmitting over the wire audio frequencies coded to select the correct motor and subsequently control its speed. At the motor end the signals are de-coded and the appropriate voltage is then applied to the motor selected. Up to five motors may be controlled with a maximum of eleven speeds for each motor. It is considered that this scheme will have useful application in the steel forging industry.

The English Electric Co. Ltd

Expansion of the English Electric Atomic Power Division has continued over the past year in order to meet not only the requirements of the Hinkley Point station but also the development and design of improved reactors. Facilities now include a large laboratory block for research into such aspects as atomic fuel canning materials leading to more efficient stations. Another new building which will soon be in full operation is for the machining of graphite bricks and tiles for reactors of the graphite-moderated type. Further workshop and office buildings are under construction.

During 1958 the range of English Electric meters, relays and instruments has been further extended. A negative phase-sequence relay has been introduced together with rationalised distance relay schemes and improved forms of all disc and hinged-armature relays. Standard relays are now offered with a wider range of characteristics and settings.

A complete range of moving coil a.c. and d.c. "miniature" panel instruments is now being made in case sizes ranging from 2 in. square to 5 in. × 6 in. rectangular. Reliability and robustness of these instruments has been proved by extensive tests: impact shocks of 200 g, vibration tests of up to two million cycles at peak resonant frequency and oscillatory tests of up to one million operations have all been applied with success.

1958 has been a busy year for the English Electric Company in electronic control equipment and computers and expansion of all the activities has been accompanied by the addition of a new bay to the Kidsgrove factory.

Prominent among substantial orders for control equipment received during the year has been one for magnetic amplifier and control gear for a plate mill, scale breaker and shearing line in South Africa. A similar order for Australia has already been executed.

Continued development of computers has resulted in Mark II and Mark IIA versions of 'DEUCE' being available. These computers have combined input/output facilities with automatic conversion and utilising the full 80 columns of the standard 80-column punched card. The 'DEUCE' Mark IIA also has a 50% greater capacity high-speed store. Intended primarily for use with electronic data processing systems, these computers may be fitted with magnetic tape auxiliary storage and high-speed paper tape input and output. Development of peripheral equipment has resulted in the availability of an off-line card-operated typewriter, several orders for which are now in hand.

The 'LACE' Mark II, a general purpose analogue equipment, has completed its initial stages of development. A number of orders has been received for complete equipments together with some for the supply of various units.

A concentrated programme, carried through during a period of twelve months, has culminated in the design of an air-cooled brushless alternator. This type of machine eliminates the difficulties associated with brushes in conventional alternators operating at high altitudes. The prototypes were first run during the summer and have accumulated several hundreds of hours test running, the experience gained from these tests being embodied in the final design.

The laboratories, which were first fully commissioned twelve months ago, have facilitated development and have proved their usefulness in connection with the pre-flight testing of systems and equipment, including two major constant frequency a.c. systems. In the second of these there was no trial installation aircraft, which stressed the complete confidence in the tests carried out in the laboratories.

Several new lines of development have been initiated, one of these being the investigation of control gear featuring no moving parts, in which transistors and transductors replace relays and carbon pile voltage regulators. An exceptionally small motor embodying the latest design techniques has been developed and is being used to power a new series of miniature rotary and linear actuators.

Probably the most important event from the commercial aspect has been the signing of an agreement with the Minneapolis-Honeywell Regulator Company, whereby the English Electric Company will manufacture, under licence, Minneapolis high-precision gyroscopes for use in inertial navigation systems. As rigid control of working conditions is essential for the manufacture of these delicate instruments, new buildings with air conditioning, humidity, and temperature control are being built.

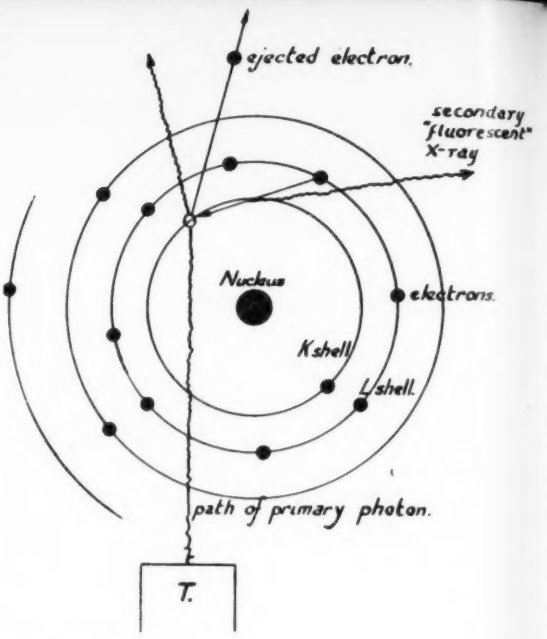


Fig. 1. Simplified diagram of the action of an X-ray photon on the atom.

By H. J. Lucas-Tooth*

X-ray Analysis— the Modern Analytical Tool

THERE is, today, a widespread topical interest in X-ray fluorescent analysis. Various instruments, suitable for routine production work, are now reaching the market, and this article tries to formulate some of the factors to be considered in the design of X-ray spectrometers, and describes the instrument which is now in production by Solartron Industrial Controls Ltd.

Basic Theory

First, a quick description of the basic theory for the benefit of any reader who may be new to the subject. This cannot but be an over-simplification and moreover it will be discussed entirely in classical language. A primary X-ray tube shown at T in Fig. 1 produces a beam of X-ray photons; these impinge on the atoms in the sample under investigation. The atom is shown as a central nucleus surrounded by orbital electrons. Quantum physics has shown us that only discrete orbits are possible and thus the electrons are shown occupying definite "shells". Two electrons fill the inmost K shell, eight fill the next L shell, etc. The path of one X-ray photon is shown and a "collision" takes place, in this case with an electron in the K shell. The electron is completely knocked out of the atom, absorbing energy from the photon in the process. This loss of an electron leaves the atom in an excited state and readjustments of the electrons in the various shells take place to return the atom to its ground state, the net result being the capture of a free electron from outside. These readjustments, however, obey strict "selection" rules which decide which electrons in any shell can jump to fill a vacant place in an inner shell. When electrons change shells there is a change in their energy and this spare energy is emitted in the form of other X-ray photons, which, of course, are "softer" or less energetic than the original primary photon. These softer photons (the so-called fluorescent radiation) can easily be seen to be characteristic of the atom concerned rather than characteristic of the primary radiation which merely serves the function of knocking out the first electron and triggering the whole sequence.

The minimum energy which it is necessary for the primary photon to possess before it is capable of removing a K electron is called the excitation potential for the K X-ray spectrum, and depends on the atomic number of the element concerned, rising to 115 kV for uranium. The primary beam needs to have an energy greater than the excitation potential of the particular element whose fluorescent spectrum is to be studied, but in practice, it is advisable to exceed this potential by about 50% to obtain a reasonable intensity. The K excitation potential for tin is 29 kV which is about the usual limit for the study of K spectra. However, as can be appreciated from Fig. 1, the L shell has a much lower excitation potential and from tin to uranium the L X-ray spectra are used. The L spectra are unfortunately less intense and slightly more complex than the K spectra.

The Spectrometer Mechanism

Having obtained X-ray fluorescent radiation characteristic of the elements in the sample under investigation,

* Solartron Industrial Controls Ltd.

it is now a question of resolving these different photon energies. It must be remembered that although the X-rays have been spoken of as photons or particles, they can also be described by wave equations and can undergo the usual phenomena of diffraction and interference. However, as the wavelength of the X-rays is so much shorter than that of visible light, the normal mechanically ruled diffraction grating familiar to optical spectroscopists cannot be used except in very extreme circumstances; it is replaced by a crystal, whose lattice has dimensions of the same order of magnitude as these X-ray wavelengths.

The fluorescent beam is collimated by bundles of tubes or thin blades held parallel, and thus a primary beam direction is defined; this beam is now reflected from the cleaved face of a suitable crystal and received by a detector through another collimator (Fig. 2). It is found in the ideal case that for any incident and reflected angle, only one wavelength, or energy, of X-rays is reflected and the remaining radiation is scattered. Thus each characteristic radiation has a particular angle for reflection and, at this angle and ignoring complications, the detector receives this radiation and no other radiation. This angle is referred to as the Bragg angle. It will be appreciated that if the sample, the X-ray tube and the first collimator are all kept fixed, to maintain the reflected angle equal to the incident angle at the crystal and yet to be able to vary this angle to set the spectrometer to different Bragg angles, then the detector arm must be geared to the crystal mount in the ratio of 2 : 1.

Single- or Multi-channel

The first major choice now confronts the designer of an X-ray spectrometer: multi-channel versus single-channel. The use of separate paths, with separate crystals, collimators and detectors, for each element whose determination is required, is attractive in many ways. It is, however, very costly, due to the multiplication of equipment and apt to be inflexible, apart from the fact that many potential users do not want to be tied down to a choice of set elements. It is also faster (due to the multiplexing) and by its very inflexibility each channel can be exactly suited to the particular element and the need for compromises can be avoided. Moreover, curved crystals with a high gain in useful intensity can be used, whereas their use in single path scanning systems is rendered very difficult by their more complex geometry. The Solartron instrument is essentially single-channel with the emphasis on flexibility and scope.

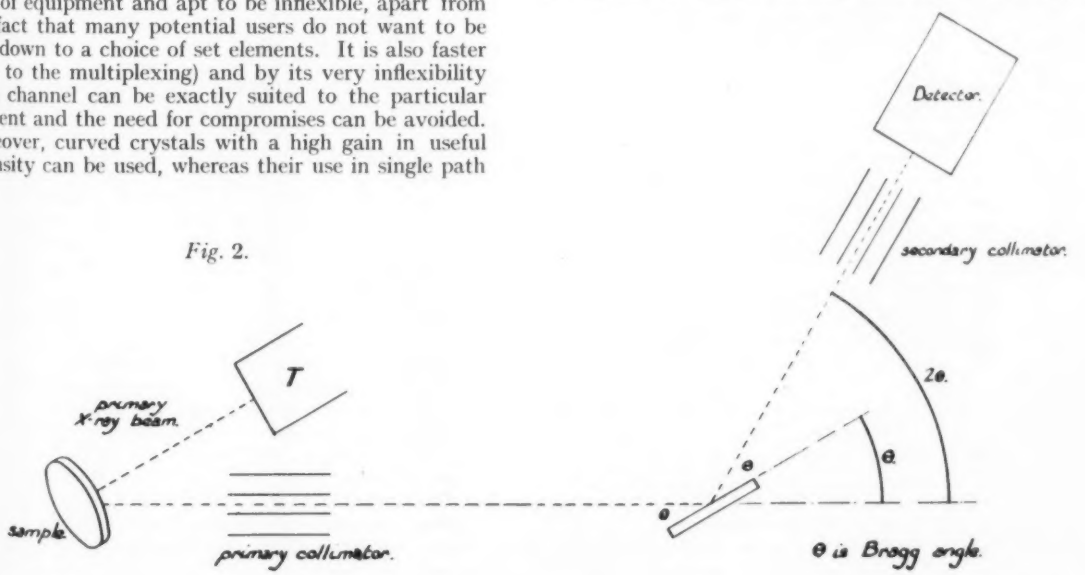
Compensation

The next factor to be considered is the method to be used in compensation for changes in primary X-ray beam intensity. There are at least three ways of doing this. First, the current and voltage of the X-ray tube can be stabilised. This is simple and attractive and can give good results. It is worth stressing, however, that this stabilisation does not necessarily ensure stable X-ray flux or that this flux always maintains an identical energy distribution. Both of these are essential factors for really accurate work, for the number of primary X-ray photons obviously affects the number of excited atoms and hence the intensity of fluorescent radiation.

Secondly, the primary X-ray beam can be monitored and a ratio of primary intensity to fluorescent intensity for a particular element can be taken. This compensation can also work well but it takes no account of any drifts in the spectrometer proper and it assumes again that there is no change in energy distribution in the primary beam.

The third and most comprehensive method is to provide a second, complete reference path. A reference sample is placed in the same primary beam and a complete duplicate system of collimators, crystals and detectors is used. Both systems are rotated together to different Bragg angles by the same 2 : 1 gearing and by taking the ratio of the detector readings, complete reproducibility against any drifts results. The Solartron spectrometer uses this system and it is illustrated in Fig. 3 which, in conjunction with Fig. 4, shows the arrangement. The sample holders and the interlock can be seen, which enable changes in either sample to be carried out without the risk of exposing the body

Fig. 2.



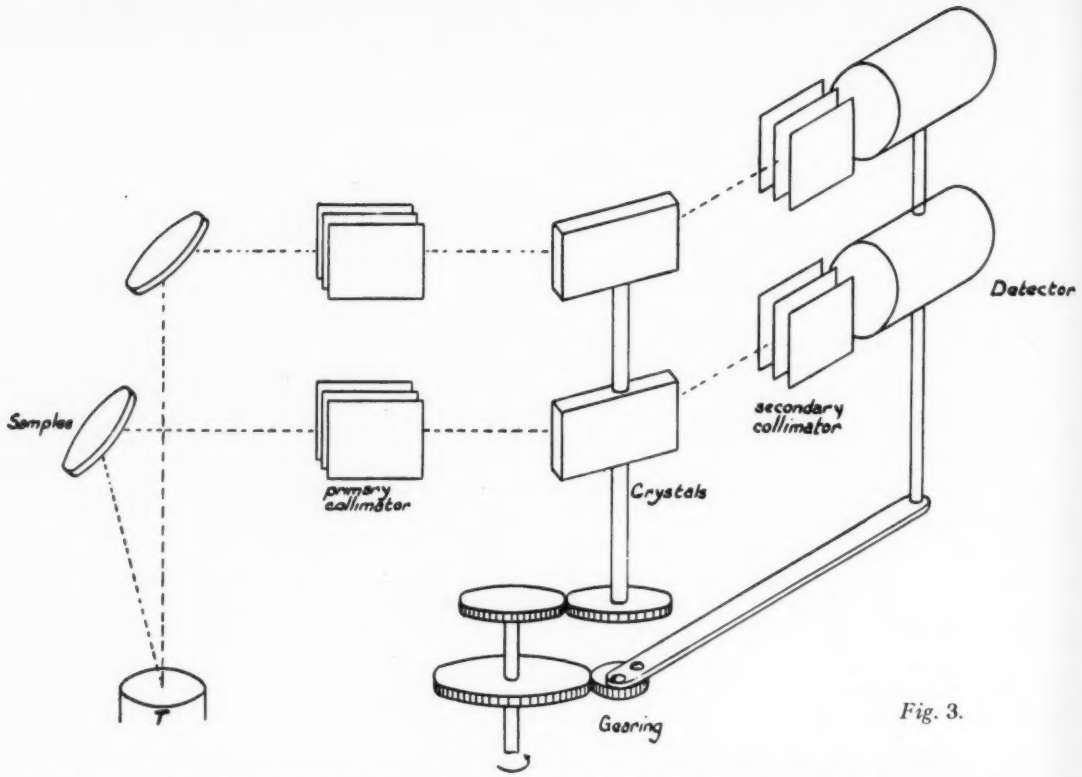


Fig. 3.

to any radiation from the primary beam. The two paths will be referred to as the reference path and the sample path.

Positioning

How to position the spectrometer at the various Bragg angles is the next question. To deal with qualitative analysis first, the spectrometer is driven by a motor and the detector is coupled to a chart recorder. The various wavelengths present in the fluorescent radiation each produce peaks at their appropriate Bragg angles. As the range of angles is swept, the peaks occur on the chart recorder. From these angles the elements present can be immediately listed. It is impossible to generalise about the ultimate sensitivity, but a peak due to a constituent present at the 0·01% level shows up clearly on the background, although in favourable cases concentrations in the parts per million range can be detected.

For quantitative work, it is required to set the spectrometer accurately at a particular Bragg angle and take a more prolonged reading. Again the simplest method is to provide a scale and do this adjustment by hand, but for large numbers of analyses each involving several elements, this can become tedious if not impossible, and some degree of automation is essential. The solution to this problem determines most other factors including speed and flexibility. The Solartron spectrometer performs this positioning by a magslip servo-system. A series of dials (up to 24 are available) are set on the Bragg angles required. For instance, if copper is required to be determined, 22·51° might be set on the first dial, then, say, chromium at 34·67°, etc., and the start button is pressed. The spectrometer automatically traverses to the copper Bragg angle 22·51° and a ratio of the reading of sample to reference is recorded. It then traverses to the next angle and so on until all the elements which have been set on the dials have been determined. The spectrometer then either repeats the analysis or switches itself off and lights an alarm.

The Recording System

The description of the recording system has purposely been left until last and will now be discussed in detail. The crux of X-ray analysis technique is that the radiation, after being sorted by diffraction, can be detected by counting the photons. A scintillation counter is used which produces an electrical pulse for each photon, the pulse height being proportional to the energy of the photon. These pulses from the detectors are counted on electronic scalers and when a certain number N_0 has arrived on the reference path, the number which has arrived on the sample path is printed out. The choice of N_0 determines the time taken for an analysis and the accuracy obtained, these are, as is usual, complementary; the longer the time available for analysis, the greater accuracy obtained. N_0 can be preset, individually for each Bragg angle. Thus, if the percentage of copper (say 70%) and the percentage of iron (say 3%) in a brass sample were required, N_0 might be set for 10^6 for copper and as a typical counting rate might be 10,000 counts/second, the copper would be determined to an accuracy approaching 0·1% of

content in about a minute and a half. The iron, at 3%, with a corresponding count rate of 300 counts/second might have N_0 set at 10^4, in which case an accuracy of 1% of content might be obtained in another half minute. Thus a result such as this would be obtained in about two minutes:

Cu 70 ± 0·1% Fe 3 ±0·03%

It was mentioned earlier that the pulse height from the detector was proportional to the photon energy. This makes possible some additional electronic filtering of the pulses and overlapping lines can be sorted and background counts cut down. These conditions can also be programmed for each channel on the instrument. Here it must be stressed again that all these programmes are entirely flexible and the angle, N_0 and the pulse discrimination conditions can be altered by the work of a few moments.

The Range of X-ray Analysis

A fairly clear, general picture of the spectrometer should now have emerged and at this juncture it is worth examining the range of the X-ray method. Fig. 5 shows the approximate wavelengths of lines in the K and L spectra against atomic number. The wavelength scale is divided into three regions. For wavelengths in region A the radiation is, at present, undetectable by orthodox commercial equipment and must rule out the determination of all elements from hydrogen to sodium. Some pioneering work is being done in this field and it is possible that in the next few years some advances may be made. The region B is heavily absorbed by air and a vacuum path is needed. However, with this attachment, the range magnesium to calcium can be covered. The region C, in which lies either the K or L series of all other elements, can be covered by the non-vacuum model. Underneath the wavelength scale there is a representation of the range covered by various crystals. Lithium fluoride has the highest reflectivity and is readily available in large, grown crystals; it cleaves easily and is cheap and trouble free.

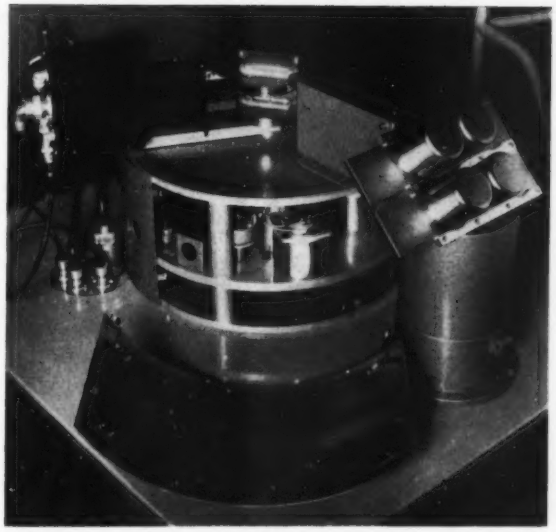


Fig. 4.

Vacuum Spectrometers

Vacuum spectrometers have their own problems. Again there are several solutions. First, a three-quarter vacuum path can be provided with the detector just outside the vacuum and a thin window to allow the fluorescent radiation to reach it. This has the merit of simplicity, but owing to even the small air gap the lowest atomic numbers in B cannot be reached. Secondly, the total path can be evacuated, but the detector electronics kept outside; this unfortunately involves intricate "O" ring seals to provide the mechanical movements necessary for scanning, but has been accomplished. Thirdly, a large dome can be put over the whole spectrometer and completely evacuated. This makes a very low pressure essential or trouble is experienced with discharges in the electronics, and long pumping times are encountered or difficult sample changing procedures. Fourthly, helium or hydrogen

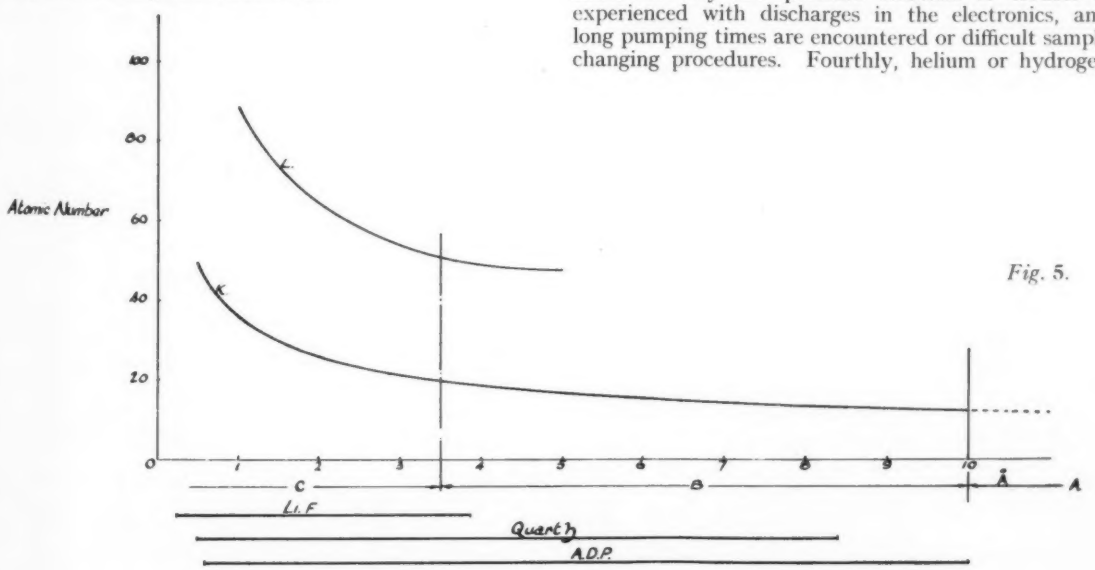


Fig. 5.

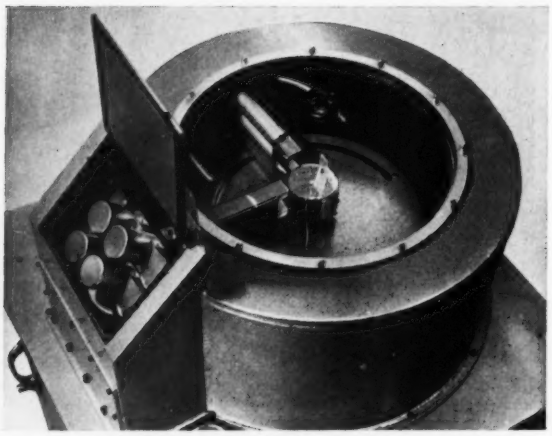


Fig. 6.

paths are possibilities, but on the one hand the price of helium is excessive in this country and on the other there are serious hazards with hydrogen. Special counters (proportional flow) are also required to detect these radiations in group B.

In the present instrument the third alternative has been chosen, the disadvantages counteracted by keeping the large dome permanently evacuated and having the sample holder in a separate, small vacuum chamber separated from the main dome by a very thin interconnecting window. This attachment to the standard spectrometer was exhibited at this year's Physical Society Exhibition. The accent is again on automation with an automatic sample changing programme, which seals off the small chamber, releases the vacuum, and then, when the sample has been changed, closes the valve and pumps it out. Interlocks are provided to prevent counting should the degree of vacuum be insufficient. Fig. 6 is a photograph of the unit.

Comparison with Optical Spectroscopy

Perhaps before giving some applications demonstrating the power of the method, it is worth comparing X-ray fluorescent analysis with conventional optical spectroscopy.

(1) Range of concentrations. Optical—from the parts per million range up to about 10%. X-ray—from about 0·01% up to the 100% level.

(2) Complexity of spectra. The K X-ray spectra are quite simple and the L spectra very much more simple than most optical spectra.

(3) Area analysed. Normally X-ray spectrometers analyse a surface about one inch square with a penetration of the order of 0·010 in., whereas optical spectroscopy usually has to rely on a point source.

(4) Inter-element absorption effects. For X-rays these have not yet been entirely worked out, but from preliminary results the effect is not only less in magnitude but also in complexity than the corresponding optical correction.

(5) Speed and accuracy. As previously mentioned, these are complementary. For an accuracy of 1% of content and taking into account the time for sample preparation and interpretation of results, it is probably fair to say that the two methods are equally fast, with a slight favour towards optical. However, one of the particular merits of X-ray analysis is that it can achieve accuracies approaching 0·1% of content given an increase in time available.

(6) Cost. Generalisations are impossible but one of the important factors to be considered is that an expensive air-conditioned room is unnecessary for X-ray work.

(7) Sample preparation. In optical work, the sample is usually required as a conducting solid or in aqueous solution, whereas for X-ray fluorescent analysis, solids both conducting and insulating, all liquids and even slurries and powders can be conveniently employed.

Industrial Applications

In the opinion of the author the most vital need for X-ray analysis is in the non-ferrous metals industry, particularly for copper base metals. Optical methods have always been difficult to apply due to the high percentage of some constituents and furthermore the range of elements covered lie in the most economic and useful range of X-ray instruments.

The steel industry, although at present firmly wedded to optical methods, finds the analysis of its special steels and high-chrome steels an increasing headache. Slag analysis, which is becoming rapidly more important, also presents difficulties by optical or wet chemical means, and the sample preparation for such methods alone takes far too long for routine use. As a parallel to this, it will be interesting to follow the needs of the nuclear reactor engineers, who, among other users, will need X-ray techniques to sort the various rare earth problems. Rare earth analysis, by any method which relies on outer electron shells, gets very complex owing to their similar structure and X-ray analysis could replace even nuclear cross-section determinations.

The petroleum industry, while confident that optical methods are the most efficient for very small concentrations in used oil tests, etc., is using and is expanding the use of X-ray methods to analyse oil ashes which contain several percent of a large number of elements. Yet again the ore mining surveyors are finding X-ray analysis quick, flexible and accurate for large numbers of routine samples.

At present, in Britain, the various industries concerned are very much alive to the benefits and scope of X-ray work; on the other hand, however, we have a great deal to learn from American experience where the use of these methods is not only widespread and familiar for routine works analysis, but also is accepted as a standard process control tool. Finally, we can predict confidently that in this country we are just experiencing the beginnings of a revolution in analytical technique.

Acknowledgments

I would like to thank Dr. E. T. Hall, Mr. P. D. Ainsley and Mr. H. R. Hindley for their kind help with this article.

Quality Control Instrumentation

Advances shown at The Physical Society Exhibition, 1959

Introduction

WHILST the Physical Society Exhibition covers the whole field of instrumentation it is of interest to trace developments in a particular sphere of activity as these may have a significance in future industrial instrumentation schemes. In the May, 1957, issue some attention was given to instruments for quality control, and it will be of interest to trace developments in the intervening two years. Substantially the same type of instruments have been reviewed, and in one or two of these, notably nuclear magnetic resonance and chromatography, considerable progress has been made.

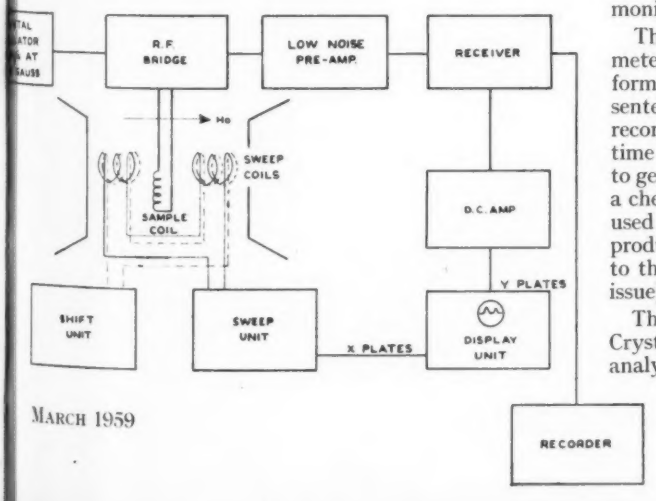
Spectrometers

Nuclear Magnetic Resonance Spectrometers

The nuclear magnetic resonance technique is already well established in the analysis and research fields of spectroscopy, and possible applications in industrial process control are now becoming apparent. The technique has been used for moisture determination in the large-scale production of starch and other food ingredients, and this could be extended to many industries where continuous measurement and control of water content is necessary.

The ability of nuclear magnetic resonance to distinguish between protons in different chemical species containing hydrogen will be of great use in the detection and measurement of impurities and unchanged starting materials in many continuous flow processes in the heavy chemical industry. Fluorine and phosphorus nuclei also give particularly strong signals and consequently nuclear magnetic resonance will be suitable for process control during the manufacture of compounds containing these elements.

Mullard nuclear magnetic resonance spectrometer.



The Fairey Aviation Co. Ltd. exhibited a prototype nuclear magnetic resonance spectrometer which has a resolution of about 5 in 10^7 with a sample size of 1/20 cm^3 and a field of 4,200 gauss.

The final production instrument will have a resolution of 1 in 10^7 with a sample size of 1/20 cm^3, and a field of just under 5,000 gauss. The permanent magnet has 4 in. diameter poles with a pole gap of 0·72 in. Temperature and field stabilisation circuits will be included.

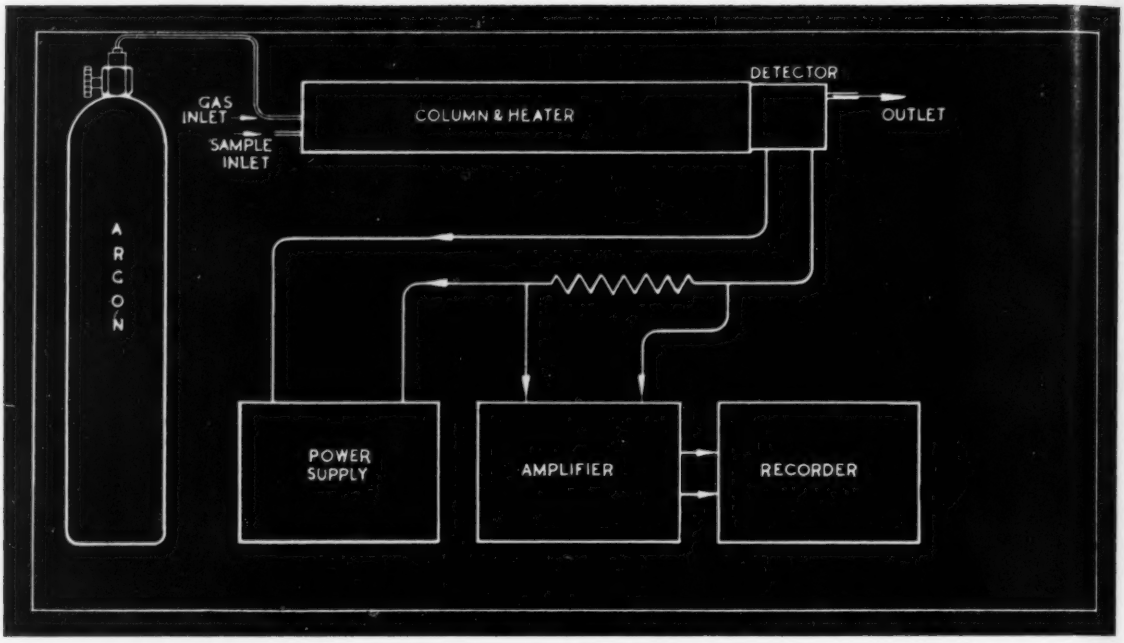
The nuclear magnetic resonance spectrometer S.L.44 Mk. 2, which was exhibited by Mullard Equipment Ltd., has a resolution of the order of 1 in 10^8. The permanent magnet provides a field of approximately 9,400 gauss and this can be varied by up to 20 gauss. The pole pieces are 6 in. in diameter and the gap is 1 in. The specimen holder is a glass tube of 3 mm. internal diameter. The magnet assembly is temperature controlled to within 0·1°C.

X-ray Fluorescent Spectrometers

The Raymax 60 X-ray fluorescence spectrometer, manufactured by Metropolitan-Vickers Electrical Co. Ltd., consists of a high voltage generator, spectrometer and counting gear. The results may be presented graphically or as a tabulation. Accessories are available for converting the spectrometer for the direct measurement of the diffracted intensities, with the option of a monitor.

The Solartron automatic X-ray fluorescent spectrometer X7 736 may be used to analyse matter in any form of chemical compound. The result may be presented as a curve on a recorder chart, or as a printed record of the number of quanta counted in a given time at each Bragg angle examined. It is also possible to generate a signal which will operate alarms or control a chemical process. The equipment may, therefore, be used to perform a continuous analysis of an end-product and automatically make suitable adjustments to the process (see article by Mr. Lucas-Tooth in this issue).

The fluorescence X-ray spectrometer exhibited by Crystal Structures Ltd. is fitted with a lithium fluoride analysing crystal and a Geiger-Muller tube as detector.



Pye argon chromatograph.

The results may be presented as a continuous record on a pen-recorder, or individual readings may be taken at particular angular settings. When the K-lines are used the instrument is capable of operation over the range of elements potassium to bromine. For the lower atomic numbers an evacuable cover encloses the crystal, specimen and X-ray detector.

The Hilger X-ray diffractometer has been modified for fluorescence analysis. Two forms of instrument are made: one, primarily for research, in which the entire spectrum is scanned by manual control; and the other, for routine analysis, in which a pre-set programme of elements can be determined automatically. The method can be used for elements heavier than titanium though lighter elements could be determined as well in a vacuum.

Mass Spectrometer

The MS 7 mass spectrometer exhibited by Metropolitan-Vickers is designed primarily for the analysis of impurities in solids. The sensitivity of the method is sufficient for the detection of many elements at the level of 0·01 part/million (atomic). A complete spectrum of the elements from mass 7 to mass 240 can be obtained in a single exposure of the plate. A monitor collector-amplifier arrangement is included for determining the length of each exposure and there is differential pumping of the source and analyser sections of the tube and high temperature baking of the vacuum system (up to 250°C).

Spectrophotometer

The Unicam SP.700 recording spectrophotometer automatically records transmittance or absorbance on a linear wavenumber scale in the range from 186 mμ to 3·6 μ. The scanning speed is controlled by a gearbox with five forward speeds and fast reverse. The slowest scanning speed is 250 cm^{-1}/min and fastest 20,000 cm^{-1}/min. The spectrum is plotted on a strip chart recorder. The chart speed may be varied from $\frac{1}{2}$ in./min to 2 in./min.

Spectrofluorimeter

The instrument exhibited by Unicam Instruments Ltd. has facilities for scanning both excitation and fluorescence spectra. A liquid may be irradiated with monochromatic light of any wavelength within the range 200 mμ to 1,000 mμ and measurements made of resulting fluorescent light at any selected wavelength within the same range. Hence it is possible to determine an "excitation spectrum" by measuring fluorescent light at any selected wavelength as a function of the wavelength of the light, or to determine a "fluorescence spectrum" at any selected wavelength by measuring fluorescent light as a function of the wavelength of the fluorescent light.

For quantitative use, the wavelength of maximal excitation is selected and measurement made at the wavelength of maximal fluorescence.

Refractometer

The R.31 pipeline refractometer, manufactured by Bellingham & Stanley, is a visual instrument for direct installation on the pipeline. The principle employed is that used in the immersion refractometer. The range is normally 1·38 to 1·46 and the accuracy 0·001 refractive index. Illumination is by transmitted light and the instrument is therefore not suitable for materials that are opaque or strongly coloured. There is no restriction to flow and all parts coming into contact with the material are of glass or stainless steel.

Chromatographs

The Baird and Tatlock centrifugal chromatograph is a prototype of a new apparatus for chromatographic separations on filter paper. Compounds to be separated are applied in the form of a spot near the centre of the filter paper and the application of a continuous flow of solvent to the revolving paper disc results in sharply defined radial separations. The average development time of centrifugal chromatograms is six minutes.

In the Pye argon chromatograph an ionisation detector is used with argon as the carrier gas. The argon is excited into its metastable state on entering the detector. As the level of excitation energy of argon is higher than the ionisation potential of organic vapours, any organic vapours present in the carrier gas are ionised on collision with excited argon atoms as they enter the detector which causes an increase in the current through the cell. The sensitivity is approximately 1 in 2×10^6 to 2×10^3 of carrier gas for full-scale deflection on the recorder. The limit of deflection is 1 in 2×10^8 of carrier gas, or 10^{-11} moles.

Polarographs

The differential cathode ray polarograph exhibited by A.E.R.E. is a development from the linear sweep cathode ray polarograph. Provision is made for the measurement of the difference in current between two cells. The direction of potential sweep can be reversed to permit thermodynamic reversibility of reactions to be studied and variable slope correction is provided to facilitate peak measurements at high sensitivities.

The Mervyn-Harwell square wave polarograph Mark III will detect and measure trace elements in the presence of major constituents at ratios of 20,000 to 1. Very little pretreatment of the sample is needed compared with the requirements of classical polarography. In classical polarography the simultaneous determination of several constituents in a mixture can be accomplished provided that the concentrations of the various constituents are roughly comparable, or provided that the elements present in the highest concentrations are those whose steps occur at the most negative potentials. With this new technique, however, no such limitations exist, and mixtures of widely varying concentrations can be readily analysed.

Polarimeter

The ETL-NPL automatic polarimeter, exhibited by Ericsson Telephones Ltd., is essentially an electronically controlled self-balancing photo-electric polarimeter containing no moving parts. The optical rotations measured can be displayed on a pointer type meter, a digital voltmeter, recorded on charts with a pen recorder, or fed into servo systems for industrial control purposes.

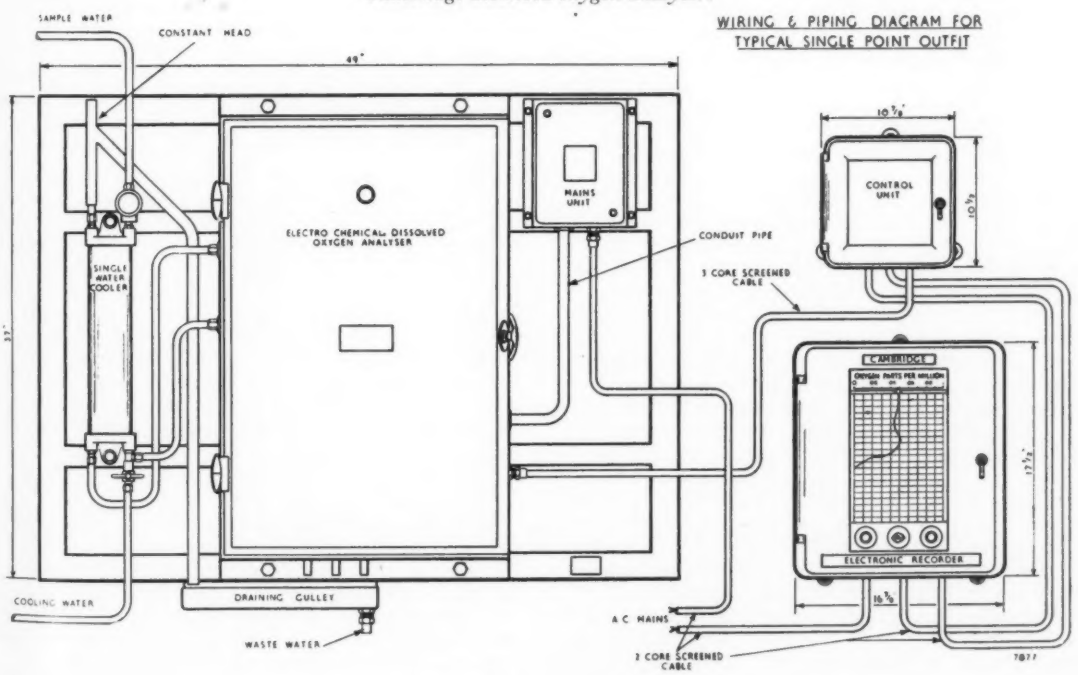
The sensitivity is of the order of 0·0001° arc. The basic range of the instrument is $\pm 0{\cdot}5°$ of angular rotation from the crossed position of the polariser and analyser. The instrument will come to within 0·0001° of its final reading within 10 seconds and will reach its final reading within thirty seconds.

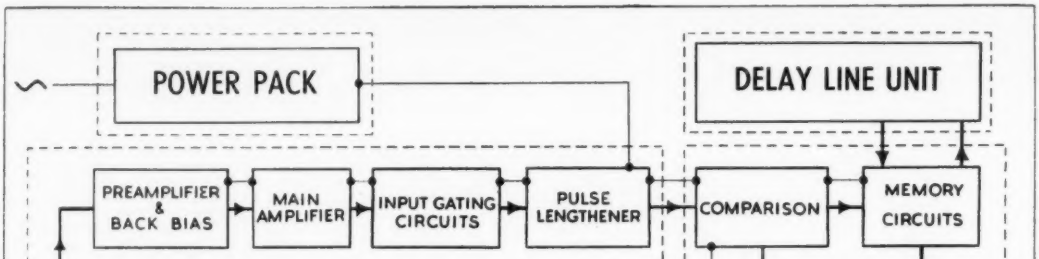
Feed Water Analysis Instruments

Dissolved oxygen analyser

The gas-phase transfer type electrochemical dissolved oxygen analyser Mark III has been developed by Cambridge Instrument Co. Ltd. to meet the requirements of high pressure, high temperature systems

Cambridge dissolved oxygen analyser.





Sunvic pulse height analyser.

employed in modern power stations. The measuring cell is isolated from interfering impurities in the feed water by the gas-phase transfer system and built-in facilities are provided for establishing zero and for calibrating at the working point. The range available is 0 to 0·03 parts per million by weight dissolved oxygen.

Silica Content Meter

The increasing use of high pressure steam raising plant in power stations and industrial boiler houses has introduced the problem of silica "carry over" which becomes serious at pressures above 900 p.s.i. The Nash & Thompson silica content meter has been developed to determine the concentration of silica in boiler feed water and to give a signal when the silica concentration exceeds a preset figure. The instrument will sound an alarm or initiate corrective action if the silica content exceeds a preset figure in the range 0·25 to 1 part per million.

The method used is to meter by means of a triple jet assembly a sample of water and the reagents into a hydraulic delay line and optical cell assembly. The cell is illuminated by a lamp supplied from a constant voltage transformer and the output of the photo-electric cell is connected directly to a micro-relay. The relay may be preset so that when an increase in concentration of silica occurs the contact closes at a pre-determined figure.

The test solutions are contained in bottles held inside the instrument case; these normally need to be refilled every three days. The bottles are fitted with constant head devices and the rates of flow from them and the flow of feed water can be adjusted and checked at a special dripper block. When the relay trips, a sample of the incoming water is trapped in a specimen bottle so that it may be examined chemically at a later date if this is thought desirable. There is also provision for injecting test water of known silica content during the initial setting up and adjustment of the instrument.

Construction of the water and reagent pathways and vessels is of plastic throughout, so that there is no danger of silica contamination.

Chlorine Content Meter

This instrument has been developed by Nash & Thompson for the detection of chlorine concentrations in potable and other waters. It will sound an alarm or initiate corrective action if the chlorine content exceeds a preset figure in the range 1 to 10 parts per million. The method of metering is similar to that used in the silica content meter.

Gas Analysis Instruments

Magnetic Oxygen Analyser

Distillers' null balance magnetic oxygen analyser measures the volume magnetic susceptibility of a continuously flowing sample of gas containing oxygen. A silica dumb-bell is suspended in the gas in an inhomogeneous magnetic field and experiences a force which depends on the susceptibility of the gas and hence on the oxygen content. This force is balanced continuously by a force generated electromagnetically by a feedback system.

Any range from 0-1% to 0-100% oxygen can be selected with a switch. The limit of detection is 0·005% oxygen in the 0-1% range and 0·25 of full-scale deflection in other ranges.

I.R. Gas Analyser

Grubb, Parsons exhibited an infra-red gas analyser which could be used for plant control. It could be used to control a combustion process. The instrument is sensitive to CO and CO_2 and measures $(CO_2) + k(CO)$; a quantity which varies steadily as the air/fuel ratio changes.

SO_2 Recorder

The SO_2 recorder produced by Electronic Instruments is based on a coulometric principle. The instrument gives a continuous indication of trace concentrations of gases such as SO_2 and is applicable for the analysis of effluent gases. The ranges are 0-10 parts per million and 0-25 parts per million and the discrimination is $\pm$0·1 part per million.

The Mervyn-Cerl automatic SO_2 recorder measures the change in resistivity of the reagent solution, when atmospheric air has been in contact with this solution, and a calibration curve gives absolute values of SO_2 in parts per hundred million. The range of the instrument is 0-80 parts per hundred million and the sensitivity ± 1 part per hundred million.

Burette Monitor

Two types of burette monitor with electronic register were shown by the A.W.R.E. In type A the liquid height in a burette is automatically registered on a paper tape; in type B the variations of liquid height are followed automatically and recorded in the form of a graph. A brass collar surrounding the burette houses a light source and a photosensitive transistor. In type A a pair of diffraction gratings are arranged parallel to the burette so that as the collar moves along the burette, the Moiré fringes are counted by the transistor. When the meniscus of the liquid is reached the light is interrupted and the counting ceases. In type B the diffraction gratings are replaced by a slide-wire resistor which is connected into a potentiometer circuit. A servo system is locked to the liquid meniscus and the collar follows the movement of the meniscus. This movement, which varies the resistance of the slide wire, is plotted by a pen recorder.

Pulse Height Analyser

This instrument is used to analyse a complex pulse amplitude spectrum, sorting the pulses into channels and counting the totals in each. With the Sunvic P.H.A.3 instrument totals can be displayed either in analogue form on the c.r.t. or read in decimal form on dekatron indicators, or automatically printed. The instrument has a fixed dead time of 250 μ sec.

With the Isotope Development's single channel pulse height analyser the channel count rate can be displayed on any recorder having a suitable synchronous chart drive to give an automatic plot of the pulse height spectrum. The instrument accepts positive going pulses 5 to 50 volts in amplitude having rise times of 0·1 to 1·5 μ sec.

Typewriter

A tabulating typewriter for automatic analysis is available from Hilger & Watts Ltd. The typewriter has been fitted to an automatic spectrograph and automatically prints the results of analyses, thus eliminating the chance of error in recording. By correct setting of tab stops and an external contact the typewriter can be made to skip over unwanted columns which is useful if only figures outside tolerances are to be typed. Automatic colour selection can be supplied; this, for example, would allow figures outside tolerance to be printed in red.

Underwater Escape from Aircraft

A series of experiments on this subject has been made recently by the Admiralty Hydro-Ballistic Research Establishment.

The measurements carried out included the acceleration of the seat and dummy subject, the pressure at various points close to where the gun separates, and on the chest and abdomen of the dummy subject. The pressures in the gun were also obtained. These accelerations and pressures were recorded continuously, so that the rate of rise of acceleration could be studied together with the changing pattern of pressure with time. Measurements were also made of the final velocity of the seat.

Acceleration was measured with a Lanelec variable inductance transducer, feeding through an a.c. bridge amplifier into a galvanometer recorder.

The pressure instruments on the dummy were made with a Lanelec variable inductance pressure gauge, essentially the same instrument as the accelerometer, but adapted for pressure measurement. For the higher pressures, closer to the separation point of the gun, a resistance pressure gauge was used, and for the still higher pressure ranges in the gun cylinder, a 2,000 lb per square in. barrel type resistance pressure gauge was found to be quite satisfactory.

For the measurement of the maximum velocity of the seat, the fixed supporting frame of the seat was fitted with a series of equally spaced coils, over which, motion of the seat moved a small permanent magnet. The output from the parallel connected coils was then recorded together with a timing frequency on a c.r.o. tube and camera. The integrated accelerometer record was also used as a check.

The major problem was shown to be the exhaust of the gun into the water on separation of the telescopic pistons. Measurements on full charge showed that pressures in the gun rose to 2,000 lb per square in. at maximum, and although normally this had fallen to something of the order of 1,000 lb per square in. by the time separation occurred, pressures measured in the water close to the chest of the dummy were as high as 23 lb per square in. positive and 15 lb per square in. negative. In air, of course, the gun pressure disperses very rapidly, but in water an enclosed bubble is formed and water resistance contains the pressure for a longer period. Furthermore, separation of the gun takes place close behind the seat as it leaves the track, and considerable damage occurs.

The experiments as a whole showed that with some small modifications to the standard ejection seat equipment, a pilot can escape from the cockpit under water by power ejection as in air. It still remains with the physiologist to decide whether in practice it is a proceeding to be recommended.

BIMCAM *Annual Luncheon*

Speakers at the annual luncheon of BIMCAM (British Industrial Measuring and Control Apparatus Manufacturers' Association) in London on 20th January were unanimous in emphasising the importance of the British instrument industry to the future well-being of Great Britain and indeed of every country throughout the world.

Sir Ewart Smith, M.A., F.R.S., a deputy chairman of Imperial Chemical Industries Ltd., proposing the health of the Association, spoke of the growing importance of instrumentation in the process industries. He pointed out how in the old days industrial plants were designed first and instrumentation was added as something of an afterthought. Today, he said, instrumentation is an integral part of the initial design. He went on to recommend an ever closer association between the instrument manufacturer and the instrument user so that an even greater understanding of each other's problems might be achieved.

Sir Ewart Smith and the other speakers were introduced by Mr. L. S. Yoxall, president of BIMCAM, who also proposed the toast to the guests.

Chairman's Speech

Mr. D. B. Pinkney, chairman of BIMCAM, replied to Sir Ewart Smith and in acknowledging the thanks of the instrument manufacturers to the plant engineers he pointed out that what instrument manufacturers were really selling was an engineering service. He outlined the aims of BIMCAM which, he said, were, *inter alia*, to maintain the highest ethical standards; to speak with a united voice for the industry and to provide a means for instrument manufacturers to meet and make friends with each other and their customers. He mentioned that the Association now represents some 42 companies with a combined annual turnover of more than 25 million pounds.

Responding for the guests, Mr. H. Landeweer, head of the Instrumentation Department, Royal Dutch/Shell Group, The Hague, called for a greater degree of free competition unhampered by national frontiers.

"It is my opinion," he said, "that it is necessary to develop large-scale co-operation between manufacturers, thus enabling them to co-ordinate their efforts in development and standardisation. Moreover, it is not a stringent law that only industries of the same nations should work together. Industries of different countries may work together and by making use of their different national traits better opportunities and results will be attained."

Quality Requirement

Mr. Landeweer went on to instance the great advances now being made in instrumentation design and manufacture in such countries as Germany and Japan. He emphasised that in his opinion the foremost requirement in instrumentation is quality. He concluded by reminding the members of BIMCAM that industrial instrumentation not only increases the efficiency and profit-making capacity of the process industries, but in addition, basically assists in raising the standards of living on a national and world-wide scale.

Automation Instrumentation at Vauxhall Motors

Part 3

by Rolt Hammond, A.C.G.I., A.M.I.C.E.

In this, the concluding part, the author describes boiler house instrumentation.

Introduction

THIS article describes the high-pressure hot water plant which has the distinction of being the largest plant of this type in the world, and therefore of outstanding importance from the instrumentation point of view. Previous articles have dealt with various aspects of instrumentation as applied to quantity production of an exceptionally high standard, both in actual production of engines and vehicles and in gauging machined components at high speed and to very close tolerances.

Heating Systems Compared

One of the most important advantages of high-pressure hot water is avoidance of heat losses due to steam traps. When a steam trap discharges, the condensate which is ejected has the same temperature as the steam, so that the heat contained therein will be lost if the condensate runs to waste; in a large boiler plant, this loss can be quite considerable.

Apart from steam trap losses, however, heat is also lost because of trap hold-ups; if a trap is choked, the apparatus served by it may become cold; or lines of steam piping may be waterlogged or air-bound due to steam trap difficulties. Such difficulties must inevitably cause waste and loss of production.

Practical experience has proved that where conversions have been made from steam space heating to high-pressure hot water heating, savings in fuel consumption up to 20 per cent have been made. For a large industrial plant, comparable in output to the one considered here, the following is a summary of the main advantages gained. Mains can be run almost regardless of level and for long distances, if they are thoroughly well insulated. Circuits for process heating can be readily maintained at constant temperature, the space-heating circuits being modulated in accordance with ambient temperature conditions. There are no steam traps or similar apparatus to be maintained; corrosion in piping is reduced, or even eliminated; and since the high-pressure hot water is pumped around the circuit, this will be independent of temperature.

The Boiler House

Two noteworthy features of the boiler house are its striking architectural design and spacious internal planning. The plant consists of five high temperature hot water boilers, designed and built by La Mont Steam Generator Ltd., Wembley, Middlesex, which have a maximum continuous rating of between 70 and 80 million British Thermal Units per hour when fired with boiler fuel of heavy type (Fig. 1). The entire system is artificially pressurised, normal working pressure being about 200 lb per sq. in. and the flow water temperature ranging from 340 to 350°F. The hot water is used for space heating both in the new large extension to the factory and also in certain existing factory buildings. This water is also employed for various process applications, the anticipated load on the plant being about 400 million British Thermal Units per hour, divided about equally between space heating and process heating. The plant came into operation in October, 1956.

The boilers are mounted on an elevated firing floor, and although this is not essential for oil firing, the plant has been designed so that it can be converted to coal firing with chain grate or similar mechanical stokers at a later date if such conversion is necessary. Fuel oil storage of ample capacity has been provided. Space has been left in the boiler house for a sixth La Mont installation and the package type steam boilers have been installed in order to provide steam of the necessary high temperature for certain processes in the factory. Each of these units is rated at 27·5 million British Thermal Units per hour.

Each La Mont boiler is fitted with oil firing equipment installed by Hamworthy Engineering Ltd., Poole, Dorset, and for each boiler there are five 16F type pressure jets operating at 240 lb per sq. in. with a maximum pressure drop across the burner throat of 1·5 in. water gauge at 60°F. The boiler fuel has a viscosity of 3,500 seconds Redwood No. 1 at a temperature of 100°F. The quantity of fuel consumed by each burner at the above pressure is 135 gallons per hour. There is one set of Danfoss flame failure equipment for each

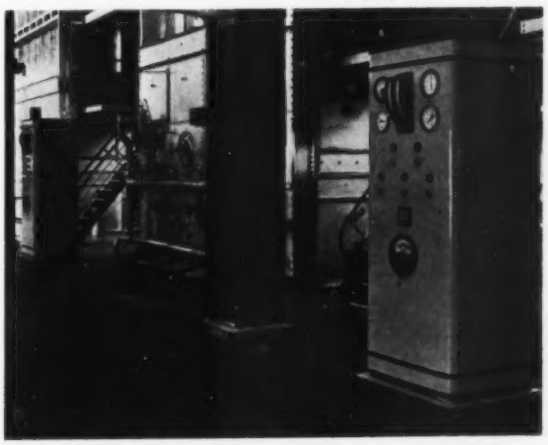


Fig. 1. Cubicle boiler-front panels showing the oil burners of one boiler.

burner, which is also fitted with magnetic valves made by Alexander Controls Ltd.

There are three oil pumping and heating units, each designed to handle 2,500 gallons per hour of oil at a maximum pressure of 250 lb per sq. in. Each unit has an electrically-driven Hamworthy pump coupled to a motor of 15 horsepower operating on a three-phase 50-cycle alternating current circuit at 400/440 volts. The triple oil heater has been designed to raise 2,500 gallons per hour of fuel oil through 180°F from a temperature of 100°F. A remote controlled pressure relief valve was installed by Thermocontrol Instrument Co. Ltd. and the electric line heater is a Duncan Low 54 kW unit arranged in three separate circuits, each with a controlling thermostat and a safety thermostat for the oil heater as a whole.

Combustion of Fuel Oil

At this stage it is important to consider the combustion of fuel oil. Before the latter can be burned cleanly and efficiently, the fuel must be brought to a viscosity whereby it can be atomised into a fine state of dispersion: intimate mixing of the oil with the required volume of air for complete combustion will thus be achieved. Atomisation of the oil occurs in the sprayer or atomiser and the actual breakdown of the fuel results from conversion of the pressure energy of the liquid into a force which disperses the fuel in the form of fine particles.

The greater the pressure energy available, the greater will be the disrupting force acting on the particles of fuel oil and therefore the finer will be the atomisation. The Hamworthy pressure jet system of oil burning has been designed to give a fine degree of atomisation to the fuel with the aid of an atomiser which usefully employs the pressure energy imparted to the fuel by the pump. Optimum atomisation can be achieved only if the fuel oil is heated to a temperature given on a chart. A finely divided fuel spray having been obtained, the second stage in combustion is to ensure that the necessary volume of air required to burn the fuel is brought into intimate contact with the particles of fuel.

In order to obtain unified control of the oil pump outputs from more than one pumping and heating unit at any given time, a pressure relief valve has been fitted into the cold oil delivery header which is common to all units because a branch from each unit pump delivery feeds into this header. The oil relief valve control wheel is set to the best operating condition in each pump in order that the maximum quantity will be discharged at maximum pressure. Control of the desired flow and pressure of the fuel oil at the boiler fronts will now be determined by the remote-controlled pressure relief valve. Oil spilled from this valve is piped back into the suction pipe from the storage tanks to the units. The remote-controlled pressure relief valve is a double-seated valve actuated by an electric motor operating on a low voltage circuit; this motor is controlled by a manual controller located in a position convenient for the boiler operator.

Flame Failure Instrumentation

The flame failure equipment comprises three main devices: a photo-cell viewing head; a photo-cell relay; and a solenoid-operated oil valve. The aim of this apparatus is to safeguard a boiler by preventing unburnt oil from being discharged into a hot furnace either before or during any attempt to re-light the burner. This is achieved by arranging a photo-cell viewing head suitably located in relation to the oil burner so that it can "see" the flame under all conditions of combustion. In the Hamworthy equipment, this apparatus is located alongside the sprayer carrier tube, thereby ensuring constant vision under all circumstances.

The photo-cell viewing head is wired back to its relay which is connected in circuit with the solenoid valve in the oil supply pipe to the burner. When the flame is established, the electric circuit is made and the oil valve is held open, but the valve is not self-lifting; a lifting handle is fitted to the valve for opening purposes only. If the flame fails, the electric circuit will be broken and the oil solenoid valve will be closed, cutting off supply of oil to the burner.

Automatic Control System

The entire boiler installation is equipped with the air-operated automatic control system developed by George Kent Ltd. The two main items in the control room are the distribution panel and the automatic control panel for the boilers. Distribution to various consumers throughout the factory is registered by "Commander" circular-scale flow indicators and "Multelec" British Thermal Unit recorders mounted in the outer-wing sections of the distribution panel. The

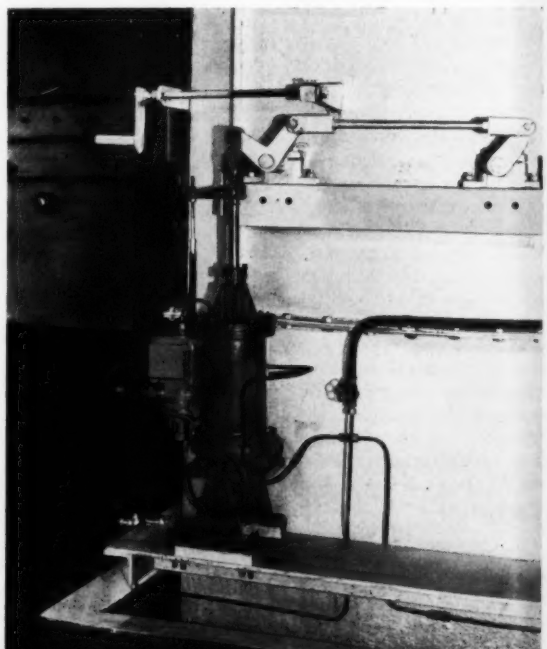


Fig. 2. Forced-draught-fan power cylinder.

central section of this panel contains pressure gauges for fuel oil, pressure vessel (which is charged with nitrogen) and heat exchangers; a "Universal" pH recorder and conductivity recorders for feed-water; "Commander" indicators and recorders for both water and steam flow to the heat exchangers and steam flow to ovens; and a multi-point indicator for fuel oil temperatures in the storage tanks and in the boiler house.

There is also a "Commander" indicator which shows the water level in the head tank; a "Multelec" two-point recorder measuring the temperature of the flow and return lines to and from the heat exchangers respectively; a "Multelec" air temperature recorder and four head-pump controllers. A central desk-panel section contains the push buttons for the pumps and a 24-point switch box.

The automatic boiler control panel is arranged in the form of a curve facing the distribution panel and is divided into sections, each section containing complete instrumentation for one boiler. Provision has been made on this panel for the instrumentation for a future sixth La Mont boiler. This instrumentation for each hot-water boiler involves four draught gauges measuring draught at the combustion chamber, at the boiler outlet, at the forced-draught fan and at the wind box for the oil burner equipment.

Indicators of "Commander" type are provided for water and oil flows, the measurement of oil flow being effected by a differential-pressure transmitter at the orifice location. Flow and return hot water temperatures are measured by two edgewise indicators. A "Multelec" recorder gives a combined record of oxygen content and temperature of the flue gases; induced draught is controlled by a Kent FAF diaphragm type furnace pressure controller actuating the power cylinder of the induced draught fan. The power cylinder of the forced draught fan (Fig. 2) is positioned by a ring balance air-flow indicator controller, the desired value of which can be set manually from the panel.

Instrumentation for each of the two package type steam boilers consists of a "Commander" combined steam flow and pressure recorder; a combined water flow and temperature recorder; and an oil flow indicator/receiver measuring flow of fuel oil to the burners. This receiver is actuated by a differential pressure transmitter at the orifice location. Conditions of the flue gas are recorded by a "Multelec" combined oxygen and temperature recorder (Fig. 3).

In front of each hot water boiler, on the firing floor, is a cubicle panel containing gauges and repeat indicators for the guidance of the boiler operator. There are two draught gauges tapped into the combustion chamber and burner wind box lines respectively; a smoke density indicator, wired into the boiler control panel circuit; and two gauges for boiler pressure and boiler differential pressure respectively. Another gauge measures the pressure of oil fuel to the burners and fuel oil temperature is also indicated.

A single cubicle panel mounted in front of the two package steam boilers is equipped with local instrumentation for both boilers, consisting of two smoke-density indicators (one for each boiler), a controller of fuel oil temperature and another one of fuel oil pressure. There is a comprehensive alarm system for the whole boiler plant which gives warning of flame failure, excessive smoke density, pump failure, or abnormal temperature.

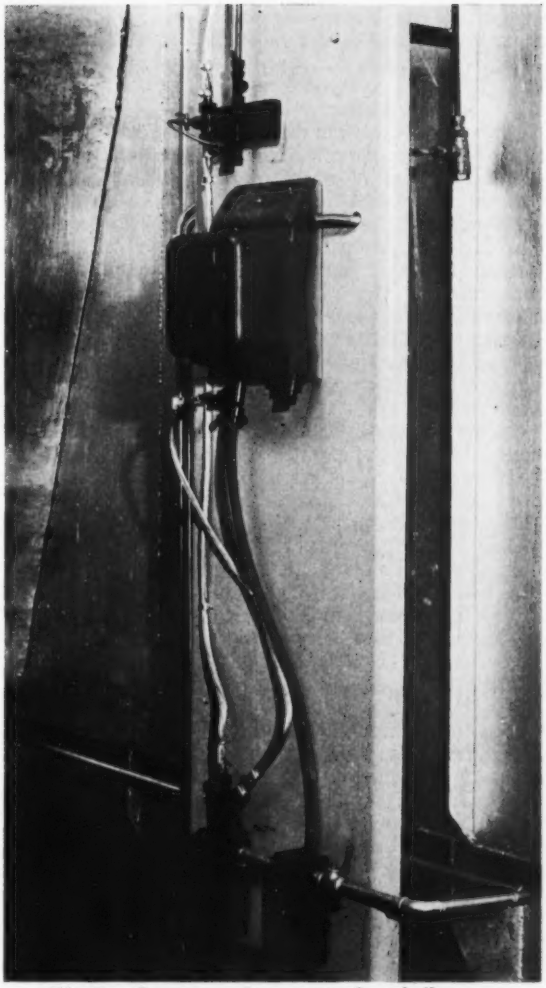


Fig. 3. Oxygen analyser on package boiler.

Combustion Efficiency

One of the most interesting aspects of this boiler plant is the measurement of oxygen content instead of carbon dioxide content of the flue gases as a guide to combustion efficiency.

Inadequate combustion air results in combustible materials being carried up the stack and discharged into the atmosphere as black smoke, causing atmospheric pollution. It may have the further disadvantage of heating the combustion chamber to a temperature at which maintenance cost may become excessive. Conversely, if the volume of excess air is too great, fuel will be wasted in heating this air to no purpose. The loss for a given rate of combustion will increase with increase in volume of the flue gas, while the heat carried away per unit volume is determined by the specific

heat of the gas. The sensible heat of the gases resulting from combustion is the most important factor, and next to this comes the sensible heat of the excess air. A high flue gas temperature is often an indication of too much excess air.

Although the carbon dioxide content of the flue gas is a guide to the percentage of excess air for combustion, the disadvantage of using carbon dioxide measurement as a basis for combustion control lies in the fact that the relationship between percentage carbon dioxide in the flue gas and percentage excess air varies between different types of fuels. This variation is due to the difference in the proportions of the combustible materials, such as carbon, hydrogen and compounds of these elements. On the other hand, the relationship between percentage oxygen in the flue gas and percentage excess air is practically constant irrespective of the type of fuel.

In an average industrial furnace, such as the type we are considering here, there is only limited time for combustion to take place before the furnace gases are discharged from the furnace, or before they meet relatively cold surfaces which chill them below ignition point. For fuel economy and in order to avoid atmospheric pollution, combustion must be completed during this limited time. It is therefore necessary to provide adequate air, over and above the chemical equivalent of the fuel, so that the last traces of the fuel can burn at sufficient speed. The speed of combustion of these last traces of fuel will depend upon the concentration of oxygen remaining in the furnace; that is, the residual oxygen concentration or flue-gas oxygen. A claim has been made, therefore, that residual oxygen concentration is the proper fundamental criterion for combustion control.

Combustion control, whether manual or automatic, eventually involves the control of the fuel/air ratio; in other words, the provision and maintenance of just sufficient air for the particular type of fuel and furnace at all loads. A direct measure of the correctness of this ratio is the residual oxygen concentration expressed as a percentage by volume of the gases leaving the furnace. The term "excess air" describes the residual air expressed as a percentage by weight of the oxygen chemically required for complete oxidation of the fuel. This comes to the same thing as the residual oxygen expressed as a percentage by weight of the oxygen chemically required for complete oxidation of the fuel.

"Magnetic Wind" Principle

Until comparatively recently, no suitable industrial instrument was available for oxygen analysis, but during the second world war the "magnetic wind" principle of oxygen measurement was put into practice in Germany. Since the war, the application of this principle has been developed and perfected in Great Britain. This instrument has been well tried in practice, both as a recorder and as an automatic controller; it requires very little maintenance and does not demand supplies of chemicals or of combustible gases, since it depends for its operation only on the physical measurement of the paramagnetism of oxygen.

Amongst the common gases, only oxygen, nitrous oxide and nitric oxide are paramagnetic, or attracted into a magnetic field. Of these three, oxygen is the most strongly paramagnetic, and cold oxygen is more strongly attracted than hot oxygen. Other gases are weakly diamagnetic, their susceptibility being negligible in comparison with that of oxygen. Since nitrous oxide and nitric oxide are not present to any significant extent in flue gases, the paramagnetic oxygen analyser is specific for oxygen.

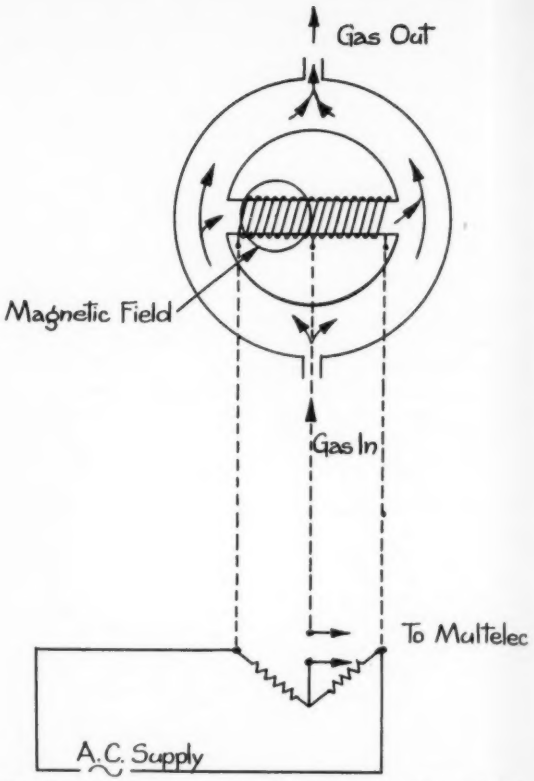


Fig. 4. Oxygen analyser cell diagram showing principle of operation.

The magnetic wind principle is shown in Figs. 4 and 5. The flue gas sample flows around the annular chamber, across which is mounted a thin glass tube carrying a platinum winding through which a current is passed to heat the tube. The winding is tapped in the middle, and the two halves form two of the arms of a Wheatstone bridge. The circled area on the left of the cross tube represents a strong magnetic field produced by a permanent magnet. When the gas sample contains oxygen, this is attracted into the magnetic field, at the left hand end of the cross tube, the heated gas in the tube being displaced towards the right because it is less strongly attracted. Thus a magnetic wind is created from left to right through the tube, and the velocity of this wind is proportional to the concentration of oxygen in the gas sample.

The magnetic wind cools the left half of the platinum winding more than the right half, thereby causing the electrical resistance of the left half of the winding to drop below that of the right half, resulting in an unbalance of the Wheatstone bridge.

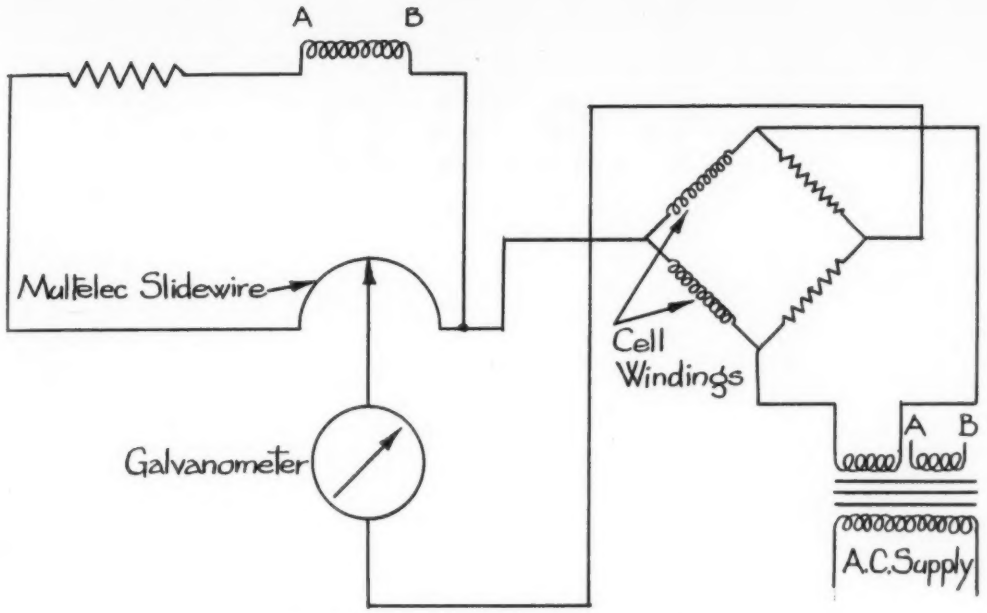


Fig. 5. General arrangement of apparatus.

Effect of Air Leakage

Leakage of air, other than combustion air, into the furnace or flues before the sampling point has a far more serious effect on the efficiency of the oxygen analyser than it has on other gas analysers, such as a carbon dioxide instrument. This is because the diluent air brings in as one of its constituents the actual gas which is being measured by the oxygen analyser, whereas this air acts on the carbon dioxide recorder only as a neutral diluent. For example, if after combustion was finished 5 per cent of air (volume percentage of flue gases) leaked in, the oxygen concentration shown by the oxygen analyser would be increased by about 1 per cent of oxygen. If the oxygen were being controlled at about 2 per cent for fuel gas, this leakage would be equivalent to a 50 per cent error in the scale reading of the oxygen controller, which would be intolerable for control purposes. The same amount of air leakage would cause a difference of only 5 per cent of scale reading in the case of a carbon dioxide recorder; for example, 0·5 per cent of carbon dioxide when recording at a carbon dioxide content of 10 per cent.

Oxygen analysis of the flue gases cannot, therefore, be used at all for combustion control where leakage of air into the furnace or flues will give rise to errors greater than can be tolerated for the particular control application.

Oxygen Analysis at Vauxhall Motor Works

In the case of the new boiler plant at Luton, a Kent "Multelec" recorder gives a combined record of oxygen content and temperature of the flue gases. This provides a side-by-side synchronised record of temperature and oxygen content, thereby enabling a continuous assessment of stack losses to be made; such a record is invaluable in determining the optimum attainable combustion conditions, which are essential to the maintenance of maximum efficiency. This instrument, operating on two individual circuits, is essentially two indicator-recorders in one. Temperature measurement is by a resistance thermometer, embodied as one arm of a Wheatstone bridge circuit.

A separate potentiometer circuit is employed in the "Multelec" instrument for measurement of oxygen content. In this circuit, the e.m.f. produced by the primary element, varying with changes in oxygen content of the gas being analysed, is continuously compared with the e.m.f. due to the potentiometer circuit. A sample of from 40 to 60 litres per hour is passed through the analyser, ensuring a rapid response to changes in oxygen content. The instrument begins to register a change in oxygen content within 5 seconds of its occurrence at the analyser inlet and gives 95 per cent response in 45 seconds. It incorporates fully automatic compensation for variation of ambient temperature, and calibration remains unaffected by small amounts of hydrogen or other gases. A simple flow indicator-regulator indicates and regulates the flow of gas samples through the analysis cell; variations in flow from 150 to 1,000 cubic centimetres per minute do not affect accuracy, neither is the latter affected by voltage or frequency variations.

Acknowledgments

The consulting engineers responsible for the design of this remarkably fine boiler plant were G. H. Buckle and Partners, to whom the author is grateful and he also wishes particularly to thank Vauxhall Motors Ltd. for their willing collaboration.

Fig. 1.

F.R.E.D.

MANY devices have been produced during recent years which are able to "read" printed material or coded information by scanning letters or figures electronically. The disadvantages of these devices has been their complexity, which has resulted in the devices being very expensive and cumbersome. A reading machine intended for use in business offices and in industry should be very reliable, fast in operation, small in size and of low cost.

The principle of operation of the figure reading electronic device which has been developed recently by E.M.I. Electronics Ltd. is quite simple by comparison with these other devices. FRED can read either optically or magnetically if specially prepared inks are used.

The difficulty of producing a device which will recognise the same characters in different type faces are immense. Thus to enable the development of simple equipment a simplified stylised type face was used. Examples of this type face are shown in Fig. 1.

Using a slit, the numeral is scanned in five discrete steps. The style of the type face is such that each of the five vertical columns (corresponding to the five scanning steps) will register either as black or white.

The characters are scanned from right to left, and for each character the first digit in the code is always black (i.e., the right hand edge of each character is always black). The column registers as black if more than 60% of it is black.

For the numeral "4" shown in Fig. 2 the columns reading from right to left are

(a) mainly black
(b) mainly white
(c) mainly black
(d) mainly black
(e) mainly white

so that if black is represented by "1" and white by "0" then the numeral "4" will be coded as "10110".

Each numeral is coded in this way, and for the set shown in Fig. 1 the codes (reading in all cases from right to left) are:—

0 . . . 10111
1 . . . 11000
2 . . . 11111
3 . . . 11100
4 . . . 10110
5 . . . 11101
6 . . . 10011
7 . . . 11110
8 . . . 11011
9 . . . 11001
10 . . . 10101
11 . . . 10010

As the first digit in each code is always "1" this form of the code gives four variable digits, with $2^4 = 16$ possible combinations. Ten of these are used for the numerals 0 to 9, or twelve to include "10" and "11" for the pence columns of sterling amounts. The remainder can be used to provide other special signs if required.

The basic principle by which the machine recognises figures is therefore extremely simple. For example, if the amount of black in a narrow vertical slit is measured as the slit moves across the numeral, waveforms such as those of Fig. 3A will be obtained; these waveforms can be squared up by limiters set to operate about the amplitude X-X to give the waveforms shown in Fig. 3B.

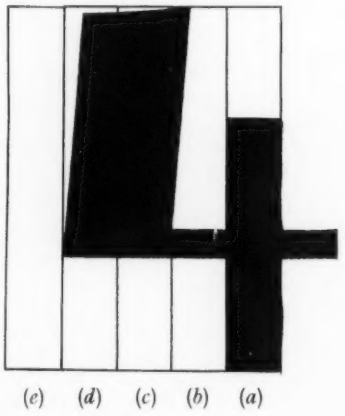


Fig. 2.

Identification of the waveforms is carried out by sampling five times, once in each column, this process being initiated by the first appearance of black in the slit (since the first column is always black) and continued at a rate controlled by the scanning mechanism of the machine. The scanning can be varied over a wide range of speed.

One of the objectives in designing a system which operates with a single slit was to be able to transform with the minimum of change to magnetic reading. Characters printed in magnetic ink are scanned by a magnetic head whose slit corresponds to the optical scanning slit of the above description. Magnetic characters are of use on documents which are liable to be handled in such a way as to increase the risk of accidental or intentional defacement; a rubber-stamped mark on a cheque, for instance, could obliterate an optical image, but would have no effect upon a magnetic image of a character printed underneath it.

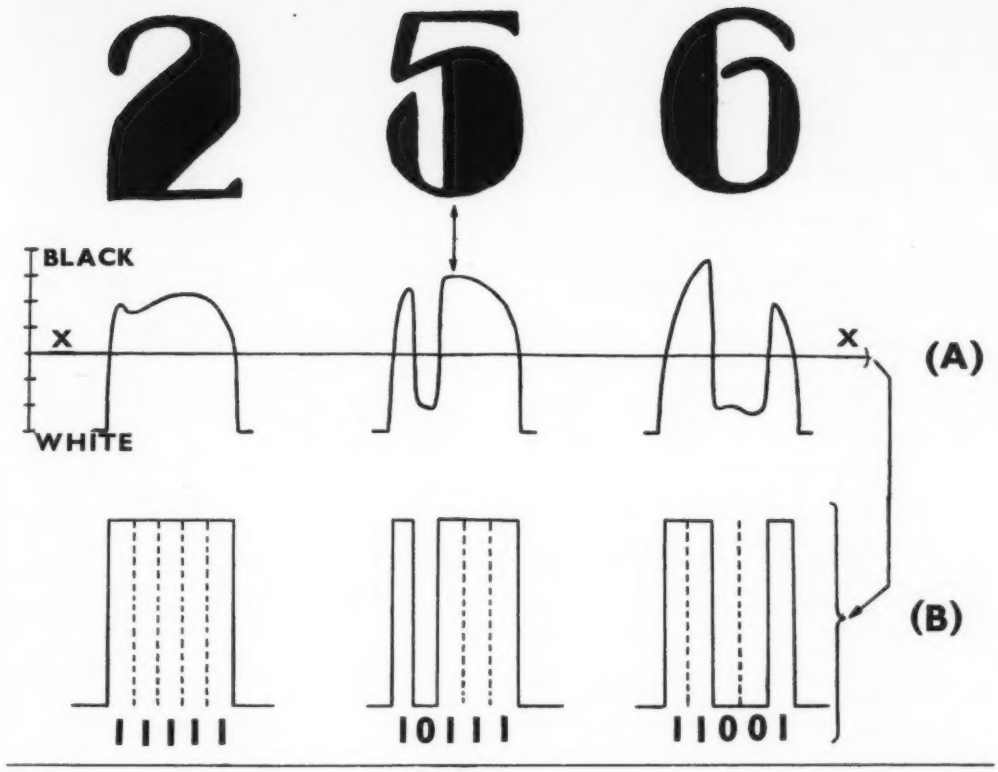


FIG 3

The use of a single scanning slit removes the necessity for accurate positioning of the character in the vertical direction. Accurate positioning along the line is not necessary, for the recognition operation is triggered off by the arrival of each character in turn. The characters can be read "on the fly", and there is no need to bring them to rest. The relative motion of the character past the scanning head can be provided by simple straight-line physical movement, with the alternative in the optical case of projecting a slit image on the characters and moving this optically over the stationary paper; this is of particular use where columns of figures have to be read, the figures being scanned horizontally and moved vertically.

Much of the information which is now fed into computers by means of punched cards or perforated tape could be prepared and read automatically into the computer using this system. Figures in the special type face printed on tape can be read at speed and printed out on an electric typewriter.

FRED can also be used for reading route information or serial numbers of objects on conveyors or railway trucks. The characters are read by moving them smoothly past the reading head. The maximum speed of operation is determined in general by mechanical limitations, rather than those concerned with electronics.

Problems of the Development of Soviet Instrument Manufacture

The following is a summary of a paper by K. Arutyunov which appeared in "Planovoe Khozyaistvo" (8), 1958, *pp.* 29-39.

Introduction

THE production of instruments in the U.S.S.R. increased 5·2 times during the period 1950 to 1957, but in spite of this the increasing industrial demand is not being fully met. During 1959 to 1965 it will be necessary to speed up the development of the instrument industry to ensure an overall output increased by four times, and an increase of more than twice this in control and regulating instruments and computing equipment. In addition, quality must also be improved.

The most important task of the instrument industry in the next few years is to develop a standard series of primary control elements and to extend the category and range of possible measurements.

Flowmeters

Remote and direct reading types of rotometers, volume meters and differential pressure gauges for use

under different conditions are required, and ultrasonic and radioactive type flowmeters must be developed. Recording flowmeters are required for use on pipelines of 80, 150 and 250 millimetres. Instruments available now will only handle flow diameters of 40 millimetres.

Pressure Gauges

The main problem is to extend the range and improve the accuracy of existing types. An overall range from 10^{-9} mm Hg to 100,000 kg/cm² and an accuracy of 0·2 to 0·5% is required.

Temperature Measuring Devices

Considerable improvement in all types of thermometer is needed within the range −200°C to +6,000°C, and there is a special need for better high-duty thermocouple materials and materials for protective sheaths.

Control Systems

One of the principal shortcomings is the lack of standardisation of instruments, primary control elements and controllers. The majority of equipment such as rotary valves, slide valves and other shut-off devices is unsuitable for remote and automatic control. It is often impossible to automate industrial processes simply because there is no shut-off and regulating equipment.

Computers provide a means of testing control systems before they are actually constructed. In many cases the simplest computers will suffice and these may be readily constructed if standard computing elements are readily available. The increasing simplicity of industry has given rise to a simultaneous increase in routine clerical work. Although computers have been used extensively in such work abroad, little has been done in this country. There is also a lack of standard punched card equipment.

Instruments and Automation Economics

Every organisation and authority has tended to develop and produce small series of "special" instruments for its own needs, and instruments developed by one organisation or authority often cannot be used in automation schemes with instruments developed elsewhere. This has resulted in waste of effort and state funds, and to correct the situation it will be necessary to establish a single State Instrument System which, above all, will ensure strict regulation of the input and output parameters of primary control or sensitive elements, controllers, final control mechanisms and other automation equipment. The single State Instrument System should make provision for the production of standard series of unified primary control elements, secondary instruments, amplifiers, stabilising elements, final control mechanisms with regulating members, and remote transmission elements both for normal use and for use in conditions of corrosive and explosive media. It is necessary to consider the maximum standardisation of automation elements and their block or unit construction elements to make possible their mass production.

BOOK REVIEW

British Instruments Directory and Buyers' Guide

United Science Press Ltd., 620 pages, 4to., cloth bound. £2 2s. 0d. net.

In past years, two publications have served the instrument industry: *British Scientific Instruments* compiled and published by the Scientific Instrument Manufacturers' Association and the *Instrument Directory* compiled by the staff of *Instrument Practice* and published by United Trade Press Ltd. The value of having one common publication to serve the interests of the whole instrument industry was recognised by both concerns, and it was agreed to merge the two separate publications into one. *The British Instrument Directory and Buyers' Guide*, now published, is the result.

It comprises some ten sections.

Section 1.—Trade and other associations allied to the instrument industry.

Section 2.—List of British Standard specifications relevant to instrumentation.

Section 3.—Consultants, engineers and installers of instrumentation schemes.

Section 4.—Firms manufacturing prototypes or small batches of instruments.

Section 5.—Classified list of instruments and instrument components together with names of manufacturers.

Section 6.—A glossary of the instrument and component headings in Section 5 in French, German and Spanish. These are in alphabetical order in the relevant language with the equivalent English heading alongside.

Section 7.—Names and addresses of instrument and component manufacturers mentioned in Section 5 together with their foreign agents.

Section 8.—A list of selected trade names.

Following these eight editorial sections are two more. One has some 400 pages of what are officially termed Manufacturers' Announcements. These are aimed to present concise details of manufacturers' products and should provide a mine of information on these. They are *not* in the nature of advertisements which have a section to themselves.

Such is the bare outline of the contents. This, however, does not convey the value of the information. For example, the classified list of instruments and components in Section 5 has over 2,500 headings covering measuring and control instruments for the normal physical conditions such as temperature, flow, pressure, humidity, liquid level and so on; automatic control systems for machine tools; automatic and manual inspection instruments; general electronic instruments; automatic data processing systems (computers, etc.); electrical instruments; aeronautical instruments; meteorological instruments; surveying instruments; gauges for physical dimensions; instruments for physical and mechanical properties; optical instruments; texture measuring instruments; analytical instruments; weighing systems; nucleonic instruments.

The Directory will be circulated extensively abroad and the glossaries in the French, German and Spanish languages are designed to interest prospective foreign purchasers in the range of instruments available in this country.

The aim has been to present the wide range of British instrumentation to all those at home and abroad engaged in the field, and everyone so engaged should possess a copy.

Basic Study into the Evaluation of Transducer-type Pressure Gauges

THE U.S. National Bureau of Standards is currently conducting a programme on telemetering transducers for the U.S. Navy Bureau of Aeronautics, the U.S. Air Force and the U.S. Army Ordnance Corps. Carried on in conjunction with complementary programmes in measurements, this effort involves the development of test methods pertinent to the selection, application and improvement of transducers. Data on the inherent characteristics of the principal types of transducers as well as a better understanding of the requirements for various applications have thus far resulted from the study.

Transducers—electromechanical devices for converting pressure, displacement, acceleration, force and similar mechanical quantities to electrical signals—are widely applicable, but are in greatest demand for missile and aircraft flight testing. In such use, the electrical output of a transducer is transmitted by a wire line or radio telemetering link to a recording device. However, a serious drawback to the use of these telemetering systems is the limiting performance of the transducer itself. The U.S. National Bureau of Standards undertook the present work in order to provide adequate data on instrument performance, and establish a satisfactory basis for transducer testing and selection.

In any evaluation of missile and aircraft flight test instruments, the environmental conditions encountered in use are of basic importance. The Bureau's transducer programme provides data on the performance of transducers over significant ranges of ambient conditions. The conditions imposed are temperature, temperature shock, pressure, vibration, and acceleration; extremes of humidity, pressure shock or acoustic vibration, are included in cases where their effects may be important.

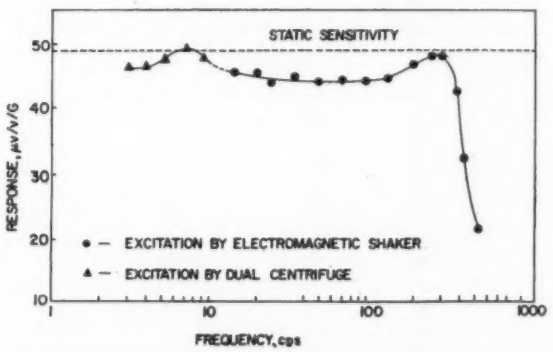
In addition to the general performance studies, attention has been focused on special problems arising in certain transducer applications. Such problems appear, for example, in pressure and acceleration measurements.

In missile and aircraft flight testing, more measurements are made of pressure than of any other quantity. One serious limitation on the use of transducers in this area has been lack of information on their dynamic performance. To obtain such data, a shock tube has been employed. This apparatus provides a pressure step-function of known value, which can be applied to the transducer pressure gauge under study; the response of the gauge is then detected by an oscilloscope and photographically recorded for further analysis.

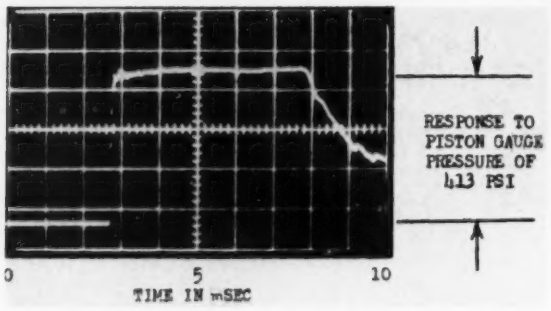
In further studies of dynamic properties, considerable effort has been expended on the testing of transducers employed as accelerometers. Calibration of such instruments presents no difficulties at frequencies from 10 to several hundred c/s. However, the frequency of interest often lies below this, a region where satisfactory test equipment has not been available. Two methods have therefore been devised for calibrations at lower frequencies. One procedure entails rotation of the accelerometer in the earth's gravitational field. The other makes use of a specially designed dual centrifuge. Either provides a known frequency input to the accelerometer under test; a response curve then represents, in the most easily read fashion, the dynamic characteristics of the device.

Such studies of selected transducers have yielded a considerable body of knowledge concerning the inherent characteristics of various types of transducers as well as an understanding of requirements in the application of transducers. At present, the number of transducers being offered by manufacturers requires a substantial effort merely to keep abreast of development. Future activity under the transducer programme will include continuation of test method development, measurement of transducer performance, and a review of the characteristics of transducers of foreign manufacture.

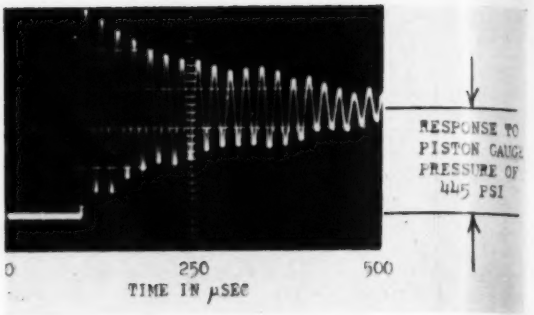
The dynamic testing of pressure transducers yields results in terms of response to step-function inputs.



Frequency response of a strain gauge accelerometer. A dual centrifuge is used to calibrate accelerometers at low frequencies not obtainable with the usual electromagnetic shaker method.



A record obtained from a quartz crystal type pressure transducer. The calculated height of the pressure step, supplied by a shock tube, was 413 *p.s.i.*



An oscilloscope record obtained by use of the shock tube from a flush-diaphragm type pressure pick-up. The amplitude of the pressure step applied to the gauge was 445 *p.s.i.*

This manner of determining dynamic characteristics was selected because step-function inputs of known pressure and over a wide range of amplitude are readily produced. On the other hand, obtaining accurately-known sinusoidal inputs in the form of pressure is difficult, except for very small amplitudes. However, the ease with which step input responses can be interpreted led to work by the Bureau's data processing laboratories to explore analogue-computer techniques for deriving frequency-response characteristics directly from step-function response records.

The shock tube was used as it is the most effective method of generating step-function pressure changes of known amplitude. Constructed of flanged steel sections, it has a working cross-sectional area 3 in. square, a compression chamber variable in length from 3·4 ft to 12 ft, and an expansion chamber 8 ft in length. The expansion chamber sections are carefully finished and chrome-plated on the interior surfaces to minimise "noise" due to shocks reflected from surface discontinuities. The compression chamber sections move on rollers to permit insertion of diaphragms.

The tube is equipped with three pairs of optical glass windows, each pair provided with a schlieren system and photomultiplier tube arranged to give a pulse at the time of passage of the shock wave. Auxiliary equipment is used to measure accurately the initial expansion chamber pressure, and to determine the transit time of the shock wave between schlieren stations.

The tube provides pressure steps lasting 4 to 5 msec. Compression chamber pressures up to 1,000 p.s.i. and expansion chamber pressures up to 350 p.s.i. can be selected. By using air on both sides of the diaphragm, shock step heights may be generated up to about 600 p.s.i. The use of helium in place of air in the compression chamber at initial pressures up to 1,000 p.s.i., produces shock step heights up to 1,000 p.s.i. The amplitude of the pressure step is determined from the measured value of the initial expansion chamber pressure and temperature and the shock wave velocity. The rise time of the step is less than 10^{-8} sec.

The dual centrifuge consists of a rotating table carrying a second smaller rotating table to which the accelerometer is fastened. Both tables rotate in horizontal planes with such a speed that the test accelerometer is carried around a circular path without rotation. Such an arrangement provides a sinusoidal input for the accelerometer, and allows electrical connections to be made directly to the accelerometer. The dual centifruge has a useful range of frequency from $\frac{1}{2}$ to 10 c/s, and a displacement that is variable up to $\pm 11\frac{1}{2}$ in. The corresponding acceleration amplitude is ± 25 g at 5 c/s and about ± 1 g at 1 c/s.

The vertical rotation procedure allows accelerometer calibration from 0 to 30 c/s, but limits the acceleration range to ± 1 g and makes necessary the use of slip rings for electrical connections.

New Patents

The following extracts have been taken from specifications obtained from the Patent Office and permission to publish has been given by H.M. Stationery Office. The Official Journal *Patents* can be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2

Patent No. 796,160. Electrically-operated Remote Control System.

Société Technique pour L'Industrie Nouville S.A. "Stin" (Switzerland). (*Application No.* 21217/55.)

The receiving end of the device transmits back to the transmitting end a signal indicating correct operation of the receiving device. This can be effected by providing an additional pair of conductors for the return signal or by the original signal being returned along the single pair of conductors. In the first alternative extra weight and expense are incurred which, when the signal has to be transmitted over a considerable distance, become significant. In the latter alternative there is no check that the signal, although correctly received and returned, has been correctly acted upon by the receiving end. These disadvantages are claimed to be overcome by the use of a pair of electrical conductors in which a direct current pulse is initiated by a key at the transmitting end. A checking circuit is provided for preventing the initiation of a further operation unless the switch elements at both transmitting and receiving stations are functioning correctly. This checking circuit comprises a receiving switch element so arranged that, on commencement of the direct current pulse, it sends back to the transmitting

station, along the same pair of conductors, a test signal derived from a different source from that of the original signal. On receipt of the test signal at the transmitter it firstly initiates the operation of a fault-indicating device and secondly operates a transmitting switch element to terminate the direct current pulse, correct operation of the transmitting switch element halting the fault-indicating device before the latter has had time to become effective.

Patent No. 796,322/323. Digital Calculating Apparatus.
General Electric Company (*U.S.A.*). (*Application Nos.* 32354/55, 35768/55.)

The first invention is concerned with the use of such apparatus for converting a number expressed in one radix to that in another. Though digital calculations in the binary system afford advantages and simplifications over those in the decimal system, it employs more than three times as many digits as the decimal system and is less familiar to human operators and is therefore more difficult to work with. For this reason it has become customary to perform calculations in the binary system but to incorporate means for receiving the input information from an operator in decimal form and to convert this into binary form within the calculator before performing the calculating functions. Devices for performing such conversions are known as radix converters and these may be decimal-to-binary converters or binary-to-decimal converters. The invention provides means for carrying out these operations applicable to converting a number expressed in any one radix to that of another. The invention requires a constant time for operation irrespective of the magnitude of the number being converted. In the second patent (796,323) the object is to provide a high speed electronic radix converter, the operating time of which is dependent on the size of the number being converted.

Patent No. 796,334. Electronic Data Storage Devices.
The British Tabulating Machine Co. Ltd. (*Inventor: Raymond Bird.*) (*Application No.* 4478/55.)

Existing designs for such devices involve the use of a gas-filled diode for data storage purposes, to which a single pulse is applied to cause the diode to conduct and two opposing pulses when it is desired the diode should remain non-conducting. The circuit arrangement necessary for securing this pulse setting of the diode imposes severe restrictions on the size of output pulse obtainable when a reading pulse is applied to a conducting diode. It is claimed that this drawback is overcome in this invention by the use of d.c. voltage levels instead of pulses for setting the diode.

Patent No. 796,600. Ultrasonic Impulse Apparatus.
Siemens-Reiniger-Werke Aktiengesellschaft. (*Germany*). (*Application No.* 10816/55.)

Related particularly to the determination of the thickness of work-pieces, the apparatus covered by this invention comprises transmitting and receiving components and serves for the measurement of small impulse travel times by the echo pulse technique. Hitherto, in the use of such apparatus for this purpose, the multiple echo impulses, rendered visible by, say, a cathode ray tube, could not be separated from each other except in special cases such as those involving a discrete series of impulse travel times. Such separation was uncontrollably dependent on physical and structural circumstances. Separation is, however, essential independently of such circumstances and this is claimed to be effected in the invention by introducing with the transmitter and receiver components a transducer and an indicating component. Between these last two are disposed means for shifting the mean frequency of the frequency spectrum to be utilised, for the purpose of separating overlapping multiple echo impulses.

Patent No. 796,999. Remote Control Apparatus.
Wolfgang Karl Schmid (*Germany*). (*Application No.* 987/58, *divided out of* 796,998.)

This apparatus is applicable to a wide variety of purposes. It comprises a transmitting device which transmits a switching impulse to an armature of a receiving device. This armature is stationary in a rotating magnetic field. The receiving device, by this switching impulse, rotates to make a switching step lasting until the impulse ceases. Both the transmitting and receiving devices comprise a contact plate provided with a number of contact segments suitable to the purpose for which the apparatus is to be used. The sliding contact of the receiving device is secured to a rotatable shaft supporting a wound armature in a rotating magnetic field, the sliding contact being electrically connected with the armature winding. Each segment of the transmitting device is connected to the corresponding segment of the receiving device plate.

Patent No. 797,079. Electric Controllers.
Igranic Electric Company Ltd. (*Application No.* 5682/55.)

This invention is particularly applicable to controllers of power-operated presses but in general relates to control of machinery in which a cycle of movement is performed. Thus in presses a ram moves in one direction to perform a pressing operation and then in the opposite direction to the starting position to complete the cycle. An important object of the invention is to insure against undesired operations such as continuous or repeat operation which could result in operators being injured or the machine or work being damaged. Control may be effected by a clutch transmitting power from an electric motor to the machine to start and operate it as a brake to stop the machine. Both brake and clutch are caused to operate by pneumatic power under control of an electromagnetically-operated valve. The invention relates to a controlling energisation of this valve so as to minimise the likelihood of injury to an operator or damage to the machine. To effect this the invention ensures that the machine will not run continuously by automatically rendering ineffective control settings for "continuous run" and by providing for operation of a machine through a given cycle requiring reinitiating of each such cycle. Means are provided by which such reinitiation is automatic but the controller has stopping means operabel at will regardless of such automatic reinitiation which then requires resetting for effectiveness after stopping.

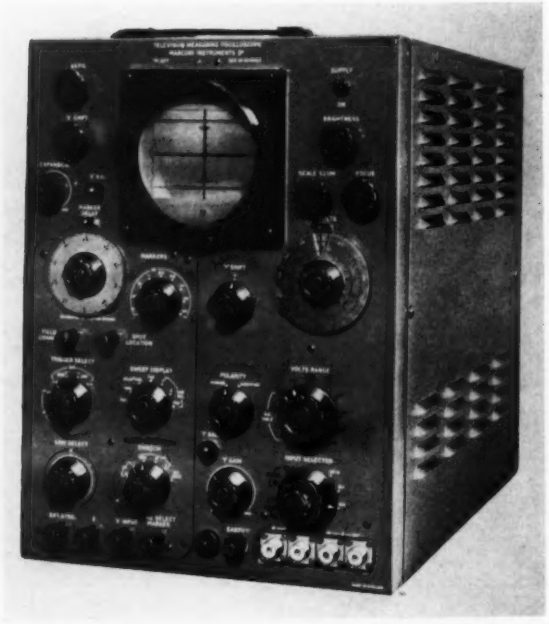
Telecommunication Measuring Equipment Exhibition

Marconi Instruments Ltd. recently held a private exhibition of their telecommunication measuring equipment. The instruments on display included signal sources, frequency meters, voltmeters, oscilloscopes and industrial X-ray units. A section of the exhibition was devoted to h.f. point-to-point communication test equipment, test apparatus for multi-channel links and television test equipment.

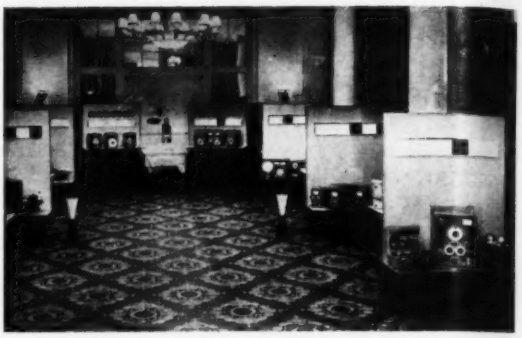
Among the new instruments was a television measuring oscilloscope Type TF1277 which enables precise measurements to be made on the waveforms used for testing television broadcast equipment, transmitters and links. It is suitable for 405-, 525- and 625-line systems, colour or monochrome, or for use as a studio waveform monitor or high-grade general-purpose oscilloscope.

The instrument is particularly suitable for the quantitative assessment of the quality of a television picture in terms of its "K" rating. The accuracy with which it displays the test waveforms used for determining picture quality allows measurement of K factors down to values well below that normally accepted as a reasonable design objective.

Either free-running or triggered sweep can be selected, and the start of the display can be delayed by a variable amount. The time base can also be switched to allow the display of pulse and bar waveforms, or to provide a line-strobe facility with a marker to modulate a picture monitor so that the line required for analysis can be readily selected from the raster.



Television measuring oscilloscope Type TF 1277.



Marconi exhibition at the Waldorf Hotel.

The d.c. coupled Y amplifier has a substantially flat response from d.c. to 10 Mc/s with a maximum sensitivity of 100 mV/cm; by using the a.c. coupled preamplifier, a sensitivity of 5 mV/cm is obtained in a pass-band of 2 c/s to 10 Mc/s.

Two coaxial Y-input sockets are provided; these can be selected independently or connected for differential measurements. On unbalanced inputs, any hum present between the earth systems of the signal source and the oscilloscope is cancelled out, allowing residual subcarrier or noise to be measured down to −50 dB on a 1 volt signal.

The response of the X-amplifier extends from d.c. to 1 Mc/s. The expansion can be varied from ×1 to ×50, with a sweep width of 10 cm at the minimum setting.

Airmec Electronic Exhibition

At this exhibition, which was held recently, the company displayed a comprehensive range of the instruments which they manufacture and sell. Of novel interest was a colour sorting machine used for sorting dried peas or beans. The machine, which is American, will be manufactured under licence in this country by Airmec.

The beans fall into a rotating bowl at a regulated rate and are picked up by vacuum on the hollow ferrules of a revolving wheel. This wheel passes the beans individually between two photo-electric tubes which examine the colour of the beans and signal the ejector to either accept or reject them. The ejector directs an airstream at the unacceptable beans which do not meet the predetermined colour and surface texture requirements and deflects them into a separate bin.

A machine which is capable of handling wet peas and beans, etc., is under development in the United States and may be manufactured under licence by Airmec later.

Instruments of Defence

Introduction

THIS article deals very largely with the future overall pattern of instrument requirements and instrument practice, in the sense of a specific application to the defence programme of NATO.

It is no exaggeration to say that all forms of defence equipment, even the unguided missiles now available in such large numbers in Europe, depend for their effectiveness on their instrument efficiency; and those instruments are tending more and more to fall within different groupings, each grouping a matter for specialists. There is the group of instruments entirely concerned with the control of motion; the group concerned with the automatic communication of data; the group concerned with the precipitation of action; and so forth. Usually, more than one group of instruments is incorporated in each vehicle, such as the ICBM, or Inter-Continental Ballistic Missile. To keep the ICBM on course, a star-track chart is used; this enables the missile, when travelling at 16,000 m.p.h., to follow a pre-determined pattern of star positions; upon arrival over the target, a large city, the minute rise in temperature encountered at operational altitude from the concentration of a dense mass of human habitations on the ground is utilised to detonate the "fire-ball" carried by the ICBM.

Broadly speaking, the instrument requirements of armies and air forces, especially in their relationship to missiles of all sorts and kinds, have much in common; the requirements of a navy, in particular of its submarine service, pose problems not encountered elsewhere, and we can here examine one or two examples, since they will serve to emphasise the extreme difficulty of securing adequate instrument co-ordination.

Submarine Missiles

To launch a ballastic missile from a submarine requires three stages of precision instrument control; to get it out of the vessel at all; to get it through the water; and to get it up into the air. The United States Navy, in working on this combined problem, devised an elaborate and very effective anchored test-rig known as "Pop-Up", which helped enormously in the solution of the basic requirements. But this still left the further difficulty caused by the vessel's motion, and it is not perhaps generally understood that a submarine, suspended in a fluid medium such as water, at no matter what depth, is never, under any circumstances whatever, still. The movement may only be slight; but an error of half a degree at the instant of launching a ballistic missile can cause it to miss the target area entirely.

Yet other disturbing factors come into this equation; space and weight in a submarine are matters out of all proportion to space and weight on land; these two specific factors, practically unrelated to missile work on land, were tackled by a "Ship's Motion Simulator". (On the other hand, directional control of ballistic missiles fired from a submarine is in some measure related to the control by the United States Army and Air Force of their Titan and Minute Man missiles.)

In a submarine, knowledge of the exact position would be essential and America has proved by two submarine voyages under the North Pole that spot-on navigation even in an area of violently disturbed magnetic conditions is perfectly feasible.

Under the Pole

The *Nautilus* trip was planned before any inertial navigational equipment was fitted to the vessel, and although by the time she sailed, *Nautilus* had received this equipment, the original plan called for two other methods of navigation. Briefly, the Sperry (gravity-controlled) gyro compass, and the Sperry directional gyro were to be employed. The former proved, in the actual event, to be accurate and reliable to within 100 miles of the Pole; the last 100 miles being accomplished with the aid of the C.11 Gyrosyn compass, with "Rotorace" bearing technique applied, in order to reduce frictional errors in the gyro movement, and marine gyros functioning as free gyros.

Rocket Aircraft

During this year, 1959, it is virtually certain that the X-15 rocket aircraft, built by the North American Aviation Corporation, will take to the sky. The estimated performance figures are an altitude of 100 miles, and a speed of 3,600 m.p.h.

At Mach 4, skin temperature will be 530°C; this necessitates interior cooling with refrigerated air; while in trajectory, since no genuine change of course is possible, pitch and yaw will be largely overcome by the use of small hydrogen-peroxide "cold" rockets in the nose; similar rockets on the wing tips will correct roll.

Satellites

What sort of instrumentation does a satellite carry, and why?

Manometers are required to measure the pressure and density in so-called outer space: a magnetic manometer for the range 10^{-5} to 10^{-7} of a millimetre of the mercury column; and an ionising manometer for the range 10^{-6} to 10^{-9}. A mass spectrometer is required to measure the gases which make up the earth's atmosphere.

For measurements in the ionosphere, an ion screen trap is required to measure the three basic kinds of free charged particles in the ionosphere (positive ions;

negative ions; electrons). These are found in concentrations of the order of from 10,000 to 5,000,000 per cubic centimetre. The sum of the concentration of negative ions plus the electrons equals the concentration of positive ions; therefore, by measuring the concentration of positive ions the complete concentration of free charged particles can be determined.

Another essential requirement is to study, by means of a magnetometer, the earth's magnetic field, about which there is still a very large question mark. It is fairly certain that the geomagnetic field, although of an unknown nature, is located inside the earth; but short-term variations in the recorded characteristics of this field appear to result from outside influence.

Sputnik III

The Russians, in Sputnik III, installed a Cherenkov particle counter to further their knowledge of the phenomena associated with cosmic rays. The condition known as Cherenkov radiation is said to arise in any substance if a charged particle moves in that substance at a speed in excess of the speed of the propagation of light in the substance. The Cherenkov particle counter incorporates a plexiglass cylinder detector with a photo-electronic multiplier located on the end face; cosmic ray particles, travelling at 186,000 miles per second, pass through this detector, thereby creating Cherenkov radiation, since the speed of light propagation in plexiglass is only 124,000 miles per second. The resultant radiation is received by a photo-multiplier, transformed to an electrical signal, and amplified for registration. Of the two groups of particles involved, that group with a charge of plus 30 is distinguished from that group with a charge of plus 17, and each nucleus is assigned to its correct group.

Possibly still more interesting is the study of solar electro-magnetic radiation, made possible by Sputnik III, whose corpuscular indicators check the particles erupted from the sun, particles which, as they near the earth, attain a velocity of many thousands of miles per second. Fluorescent screens, covered with thin aluminium foil, roughly classify the corpuscles according to their penetrating power. Diaphragms in front of the screens limit the solid angle of trapping the corpuscles, which themselves cause the screens to become luminous; the radiation from this luminosity is received by a photo-electronic multiplier which first stores it up, and then transmits the sum by means of a radio-telemetry system.

Finally, to assess the density of small, miscellaneous inter-planetary fragments, even if they are only a few microns in diameter, micro-meteor counters are employed; a piezo-element pick-up converts the mechanical energy of the striking particles into electrical energy, while their number and velocity in terms of their impact from the pick-up are transmitted to an electronic block which counts and registers them.

Fuelless possibilities

NATO must look ahead and prepare to tackle problems such as that posed by the fact of velocities for free-field movement in space are so high that, if transfer times are to be acceptably short, the solar gravitational field modifies the energy requirements to a negligible extent.

Once some sort of vehicle is out in space, a few pounds thrust coming from an electric arc, heating a working fluid, would be able to propel it. For sustained space flight, an optical device, automatically rotating through 360 degrees in order always to face the sun, might be used to collect the sun's rays, and to concentrate enough solar energy into a working fluid to provide motive power. Or again, nuclear energy as a reactor heat source could raise both the temperature and energy of a propellant by means of simple heat transference.

There are, too, many variants of the ion-propelled vehicle now under active study; but, like so many similar projects of a long-term nature, instruments will be the limiting factor when it comes to making things work. In America, a design exists for a vehicle called the "Snooper" which, developing mere ounces of thrust by means of the continuous discharge of high-speed particles, could be propelled for a year at several thousands of miles per hour, in spite of weighing approximately 3,000 lb, if once lifted into space by conventional means.

Ionised gas atoms, accelerated by an electrical potential while being forced out of a propulsion system, seems an attractive alternative; while another idea is to have an ion generator, with a device midway between a cathode and an anode to keep ions flowing in columnar fashion to create thrust in a propellant fluid stripped of electrons. Lastly, in this same direction, is the possibility of constructing an ion-rocket with a giant electron power tube, or a reverse electron diode.

Outside the Solar System

NATO member countries have even worked out practical details of assignments in solar systems far beyond our own. For such a purpose, the American Photon rocket is an attractive proposition. It derives its relatively small thrust from the expulsion of energy waves from a photo-sensitive surface, either by light falling on the surface directly, or by electronically or neutronically (i.e., bombarding it with neutrons) energising large areas of the surface. Alternatively, there are the free radicals and their possibilities; that is, to make use of damaged molecules that release energy as they follow their natural compulsion to return to their natural state. An example has been studied in respect of the United States Aerobee-Hi which, at an altitude of 80 miles, ejected nitric oxide to react with the oxygen particles of the upper atmosphere, thereby causing light plainly visible at ground level.

What special and immediate difficulties arise with regard to the instruments to be employed on such projects? Shielding them from the destructive effects of direct cosmic and thermal rays is one; evolving a means of avoiding collision of the vehicle with cosmic ray concentrations along the path of the trajectory is another; storage of collected data for ultimate transmission back to the earth at a pre-determined time when the orbit is favourable is a third.

The instruments needed must work in the absence of gravitational force, and survive unimpaired the interference liable to be caused by the propulsion

systems; similarly, they must work in harmony with the communications apparatus, and also continue to function under the stresses of the violently evasive action phases when the vehicle is dodging meteoric concentrations. Incidentally, electric batteries may feature in the plans generally; they could at least be employed to heat working fluids which, expanding through nozzles, give a small amount of thrust; such batteries would be of silver-zinc construction, or of the mercury-oxide type.

Converting solar radiation to electrical power, through the medium of thin plates of pure monocrystallic silicon, their long life would offset their low percentage of efficiency which is about ten.

Other prospects opened up by the satellite and missile developments of the next decade will include the accurate measurement of the earth's electrical field from outer space, by means of electrostatic fluxmeters—remembering that the earth itself is a charged body; the terminal guidance of space vehicles by means of infra-red scanners; instruments to compensate in a wide variety of ways for the changed characteristics of the vehicles due to the mass of their first-stage propellants being a design variable; and the precise determination of the exhaust velocity of nuclear-powered ion rockets, at present believed to be constant in time.

Controlling Thickness of Battery Separators

A RADIO-ISOTOPIC gauge capable of making micrometric readings of great accuracy is enabling the Delco-Remy Division of General Motors to control the processing of battery separator materials and at the same time provide improvements in storage battery performance.

Introduction of this new method of continuous non-destructive inspection has helped Delco engineers solve one of their most difficult manufacturing problems. The problem arises from the fact that spongy freshly calendered rubber cannot be dependably measured by standard methods. At Delco, and at other battery plants manufacturing microporous rubber separators, it had always been necessary to delay any accurate measurements of the separator until after it had passed through the curing cycle. With the new instrument it is possible to inspect, measure, and control separator thickness as the embossed sheet comes off the calendering rolls. Use of the device has enabled Delco-Remy to hold tolerances impossible a year ago. The device reads thickness to 10^{-4} in. with an error of less than 1 per cent.

Before the introduction of nuclear measurement the operators made an "educated guess" as to final separator thickness and results predicted by two experienced operators might vary considerably.

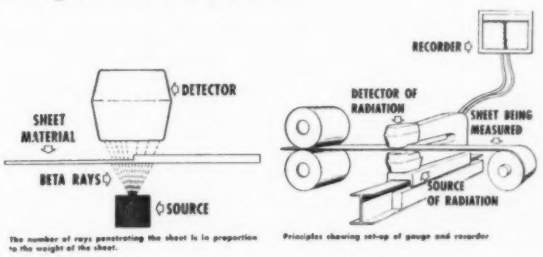
Greater uniformity of separator thickness has resulted in lowering electrical resistance about 10%, producing a battery with significantly higher terminal voltage and increased ability to crank the car engine.

The heart of the new measuring instrument is a hermetically sealed capsule containing a radioactive isotope. This isotope particle, about the size of a grain of salt, provides a constant source of beta ray energy. The detector unit is a kind of specialised Geiger counter. It is located about 2 in. above the source capsule and is filled with an inert gas. As the counter is bombarded by the rays, some of the gas is ionised. The ionising gas sets up tiny electrical voltages which when amplified and presented in visual form show up on the recorder as variations in thickness of the material.

The equipment in use at the Delco Battery plants have scanning units which resemble heavy elongated "C clamps" riding on pneumatically actuated pedestal mounted transversing systems. The radiation source is mounted on the bottom jaw of the clamp and the detector opposite it on the upper jaw. The unit is located adjacent to the calendering mill and arranged so that the separator sheeting coming off the calender rolls passes between the isotope and the detector. Thickness readings are taken from a position near the centre of the sheet.

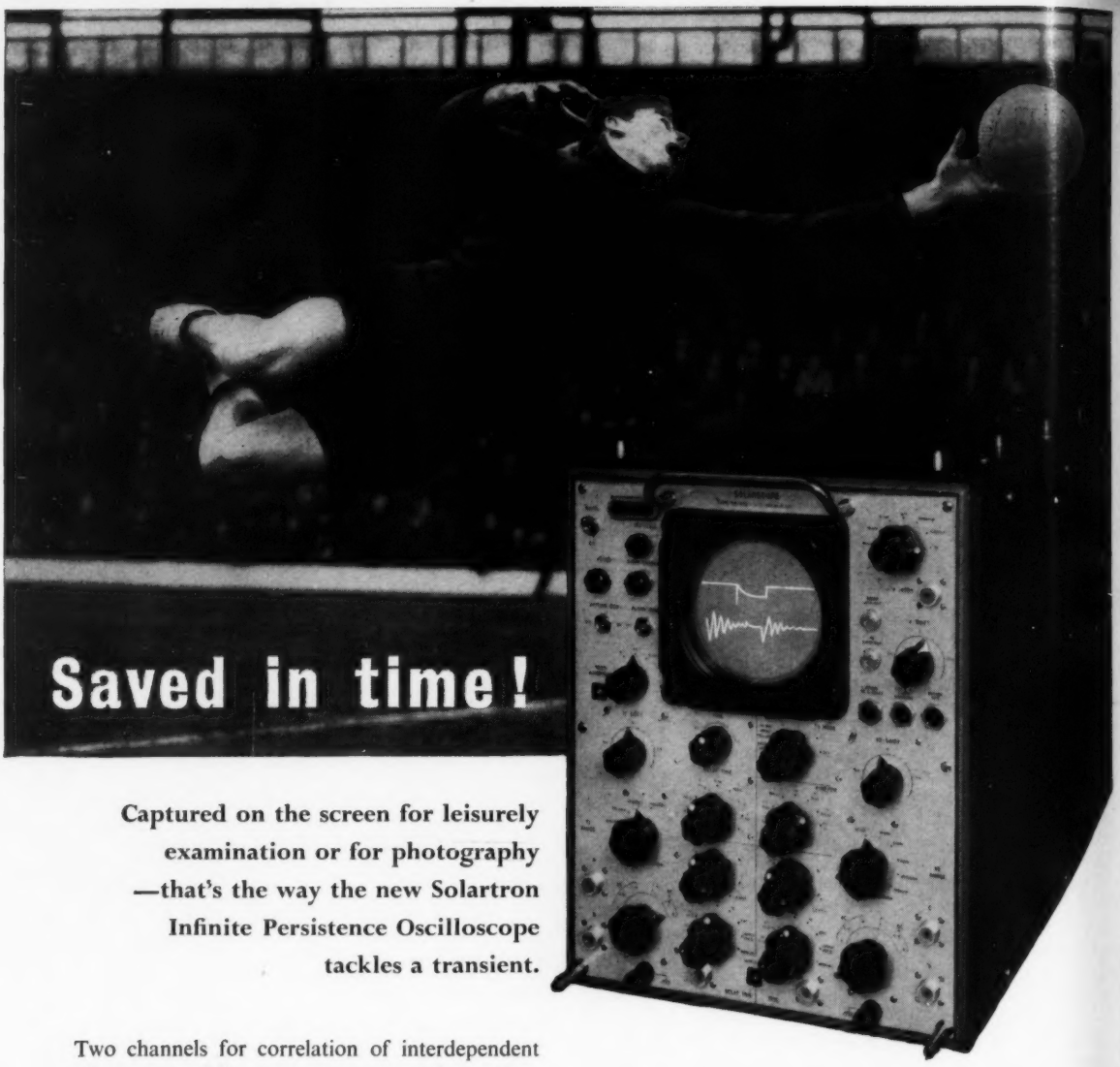
The gauge has the facility of checking on its own accuracy. Once every thirty minutes it spends 45 seconds in recompensating itself for changes in humidity, temperature, accumulations of dirt, and for any other environmental factor which might conceivably affect its accuracy. Should the machine be unable to zero itself, it shuts off, rings a bell, and turns on a series of lights showing the operator where to look for the trouble.

The direct reading recording unit has made it possible to detect any change or mal-functioning of the complicated rubber-making process almost instantaneously, and the permanent record of thickness makes a valuable process research tool. Finally, the radio-isotope gauge has proved an invaluable aid in making thinner microporous rubber separators of great uniformity thus enabling Delco engineers to build a battery with improved life and greater cranking ability without raising costs to the consumer.



The number of rays penetrating the sheet is in proportion to the weight of the sheet.

Principles showing set-up of gauge and recorder



Captured on the screen for leisurely examination or for photography —that's the way the new Solartron Infinite Persistence Oscilloscope tackles a transient.

Two channels for correlation of interdependent phenomena, full-screen sweep in a few micro-seconds or a hundred seconds, push-button erasing and stabilised brilliance of display—these are just a few reasons why the Solartron IPO is quickly taking the lead in visual instrumentation of 'once-in-a-lifetime' and transient phenomena.

No need now to waste film waiting for non-recurrent signals, every frame exposed to your IPO screen will be significant—a certain step forward in your investigations.

From the specification, here are salient features which at once denote high sensitivity and an extremely wide field of application.

- ★ **Infinite persistence plus rapid erasing**
- ★ **Dual-channel differential '71' and '72' inputs**
- ★ **T.B. delay continuously variable to 100 Sec.**
- ★ **Identical 'X' and 'Y' input channels (D.C. to 1 Mc/s.)**
- ★ **Direct time and voltage calibration**
- ★ **Triggering in these modes:**
  - **(a) Repetitive operation**
  - **(b) Single-shot with 'lock-out'**
  - **(c) Push-button with 'lock-out'**
  - **(d) Delayed, using internal generator**
  - **(e) From signal, after adjustable delay period.**

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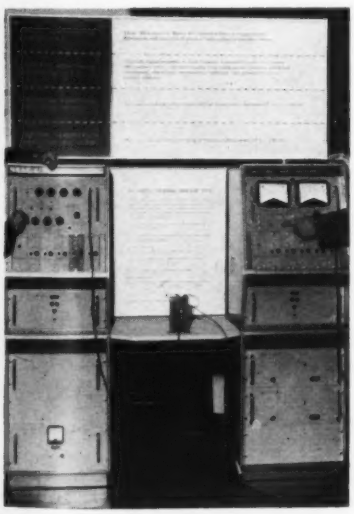
Servo Test Equipment for Industrial Control

THE new process response analyser of the Solartron Electronic Group, Limited, enables precise measurements to be made on control systems such as are required for nuclear reactor heat exchangers, metallurgical processes, chemical plant, automatic production cycles of many industrial types and numerous types of motor control when the systems are in normal operation. Accurate measurements on any slow and medium-speed dynamic system are possible even under severe non-linear and "noisy" conditions.

The Solartron process response analyser Type JY.743 is the logical development from the Solartron transfer function analyser (T.F.A.). The new instrument, the P.R.A., is for very much slower systems from 1 cycle in three hours to 100 cycles per second. This range will cover most normal industrial processes employing automatic closed-loop servo systems.

The P.R.A. provides the necessary design information for new control systems and also enables them to be proved before the production stage is reached.



Process response analyser.

It also enables all servo and control systems to be tested regularly without halting production. The necessary adjustments may then be made before any interference is experienced.

The requisite information is given by plotting phase/amplitude response (Nyquist) diagrams with high accuracy over the entire range of frequencies to which the system will respond. Because of the instrument's very high measuring sensitivity it will operate direct from transducer signals.

The P.R.A. is a double console instrument incorporating a Solartron very low frequency oscillator Type JO.744 and a Solartron display unit Type JD.745 (obtainable separately) covering a frequency range of six decades (1 cycle in 10^4 seconds to 100 cycles per second). Two wide-scale meters display the "in-phase" and "quadrature" components of the wanted signal.

The design is based on analogue computer and gated integration techniques, and standard computing amplifiers and multipliers are incorporated.

Push-buttons on the oscillator provide "prime", "run" and "hold" facilities, conditions which may also be controlled externally by, for example, a computer control panel.

Specification

Frequency Range: 1 cycle in 104 sec to 100 cycles per sec.

Frequency Accuracy: ± 1·5 per cent.

Outputs: Four phase at 200 volts peak to peak per phase.

Source Impedance: Less than 1 ohm.

Output Attenuator: On 0° and 180° only. A Kelvin-Varley potentiometer gives outputs from 0 to 100 V peak in 10 mV steps.

Attenuator Impedance: Less than 5k ohms.

D.C. Content: Less than 0·1 per cent peak to peak output.

Square Wave Output: 0 to 2·5k ohms.

Display: 2 meters 5¼ in. (13-75 cm) scale with automatic polarity indication.

Sensitivity: 3 mV peak maximum to 300 V peak maximum.

Input Impedance: 1 megohm.

Signal/Noise Handling: ± 3 per cent, full scale absolute. The input is operated at half full scale and so will handle substantial noise without desensitising the unit (i.e. a 1:1 signal/noise ratio).

Noise Integration: Below 1 cycle per second, single cycle integration is provided. Above this switchable smoothing (fast or slow) is provided.

Circle 1 for further details.

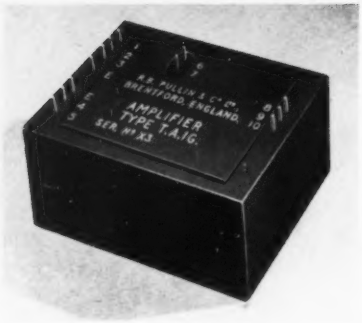
Absolute Standards of Impedance

As the velocity of light is now known to better than 1 part in a million and as linear dimensions can be measured to a similar order, it is a relatively simple matter to construct an absolute standard of low capacitance (say 10 pF) to an accuracy of 0·01 per cent. Hitherto such standards have been of little practical use because impedances of this magnitude cannot be measured precisely with an orthodox type of bridge.

Wayne Kerr have developed a bridge which will measure in this impedance range to an accuracy of 0·001 per cent. Ratio transformers can provide multiplying factors without loss of accuracy so that a standard impedance of any desired value can effectively be produced from the single standard. The significance of this new order of accuracy is demonstrated with a bridge measuring the permittivity of benzene with reference to cyclohexane, which is commonly used as a standard of liquid permittivity. Other applications are the accurate measurement of the conductivity of organic liquids, and the determination of minute traces of dissolved water in oil.

Another version of the new bridge compares impedances in the order of a thousand ohms, also with an accuracy of 0·001 per cent, and several of these instruments have already been used by the National Institute of Oceanography for studying the salinity of sea water as part of their International Geophysical Year programme.

Circle 2 for further details.



Servo amplifier TA.1G.

Servo Amplifier TA.1G

THIS amplifier is designed to provide the control phase power for size 10 servo-motor, R.124-G, or the size 10 high performance motor generator, R.807-G. With additional precautions, it is capable also of driving a suitably wound size 15 motor.

The amplifier is very compact and normally needs no additional heat sink in order to operate in ambient temperatures up to 60°C.

Length	— 2¾ in.
Width	— 2¼ in.
Depth	— 1⅝ in.
Power Supply	— 26 V 400 c/s a.c. with centre tap or 20 V d.c.
Input signal	— Error signal from synchro chain.
Output signal	— Up to 4 W into 10-0-10 V motor winding.
Controls	— Facilities are provided for setting amplifier gain by soldering of one resistor between terminals.
Input terminals	— 3 input terminals are provided to enable use of rate feed-back, etc., and facilities are provided to enable setting up of the amplifier to required performance condition.
Ambient temperature range	— Amplifier will drive size 10 motor R.124-G up to 60°C ambient temperature without additional heat sink. Additional output performance is available at lower maximum ambient temperatures or with the addition of larger conducting surfaces.

Circle 3 *for further details.*

Solenoid Valve for Viscous Oils

A NEW solenoid valve for over-spill type burners has been introduced by Teddington Industrial Equipment Limited and is now in regular production.

The valve is designed for use with fuel oil at viscosities ranging from 200 to 1,000 seconds Redwood No. 1 at pressures between 0-300 p.s.i.

A special feature is the provision of a change-over switch operated by the valve spool which enables the operation of the valve to be interlocked with the burner programme circuit to ensure that the correct sequence is initiated and/or maintained. It can also be used to operate a remote valve position indicator.

The valve proper is of the balanced, slide pattern, the valve spool being controlled by a double-wound solenoid which is employed in order to provide sufficient power to overcome the initial stiction of the oil when the plant is started up from cold. When the valve is energised, the armature—to which the spool is attached—is attracted into the solenoid core against a return spring and in this position opens one of the outlet ports and closes the other. At the same time, it operates a multi-leaf switch, the first set of contacts opening to disconnect the solenoid "pull-in" winding, and the second set changing over from one signal circuit to another. The two sets of contacts are linked mechanically, but are electrically independent.

When the valve is de-energised, the armature returns to its normal position, reversing the valve spool and the switch contacts.

Alternative outlet ports are provided so that the standard model may be used either as a simple cut-off valve or as a diverter. One of the three ports is normally plugged and by simply changing the position of the plug, the valve can be readily converted from normally-open to normally-closed operation.

A built-in adjustable by-pass is provided to enable pre-heated oil to be circulated through the valve continuously.

To ensure maximum efficiency and quiet operation, the solenoid is wound for 220 V d.c., but a small chassis mounting rectifier is available as an optional extra for use with a.c. supplies.

Circle 4 *for further details.*

Numalec Automatic Pneumatic/Electric Controller

THE Numalec is an automatic controller with a wide range of applications in both large and small scale industry. It will control temperature, pressure, vacuum, level, etc., each for set (adjustable) periods and in the sequence required.

In controlling, for example, a complete manufacturing process, it will maintain one or more temperatures at the desired values for precise periods, govern levels, pressures and draining, give warning of any supply failure and indicate the completion of the process.

In its simplest form, the controller will raise the temperature of, say, an electric oven to a set value, maintain the temperature for the required period, switch off and indicate completion of the cycle.

In all cases, operation is simplicity itself, the sequence being initiated by pressing one button. The controller is, however, so versatile that the whole programme can be changed within three minutes.

The method of construction, from standard, well-tried components, leads to a simple, reliable and economic equipment, so that even an elaborate type of Numalec costs no more than an operator's wages for six months.

Circle 5 *for further details.*

Counting Daylight

THE daylight integrating meter is designed to translate varying daylight into units which are stored on a counting meter. Thus it is possible to expose materials to daylight over any time period and to know exactly the amount of light which has fallen on them irrespective of varying weather conditions.

The unit comprises a photo-cell and special transistor integrating amplifier which drives the low inertia integrating counting meter. When maximum daylight falls on the photo-cell the meter will record a maximum count of one division in 55 seconds with the rate of count being directly proportional to the varying daylight conditions. The total count before automatic re-set is 10,000. The photo-cell is housed in a 2½ in. diameter cast aluminium case of weatherproof construction, and the distance between the cell and the control unit can be up to 100 ft. The control unit is a pressed steel housing with hinged lid, suitable for wall mounting. It contains the integrating meter, transistor amplifier and power supplies.

Units are available for operation on 20—250 V a.c. and 24—250 V d.c. Price £74 10s. 0d. per set, delivery four to six weeks.

Circle 6 *for further details.*

Spray Gun Nozzles

ALFRED BULLOWS & SONS LIMITED have recently introduced two new nozzles for use with their L200 Model 2 Spray Gun. These nozzles are the A8P and the A9P. They are intended for use under conditions calling for low pressure spraying, for instance, where exhaust facilities are inadequate and overspray must be reduced to a minimum.

The A8P nozzle has been used in conjunction with a red oxide primer with pressures reduced to 7 p.s.i. on the pressure container and an atomising pressure of 30 p.s.i. It is an alternative to the A9P, the choice of nozzle being dependent upon the type of material being sprayed.

Both nozzles cost 15/- each, plus 20%.

Circle 7 *for further details.*

L.200 Model 2 spray gun with nozzle.

Timer with High Switch Current Rating

PHOTOELECTRONICS (M.O.M.) LIMITED have recently produced an electronic timer which is capable of consistently giving accurate pre-set time intervals, over any range up to 30 minutes. The timer can be re-set at any point of the time cycle and a new time cycle started immediately.

There is no warming up period and the timer will not vary more than plus or minus 2% with mains voltage variations of plus or minus 20% of a nominal 230 V a.c. supply.

There is a rugged contactor fitted in the timer which will switch currents up to 20 amp at 250 V a.c.

The whole unit is housed in a pressed steel box 4 in. × 4 in. and can be supplied for wall or flush mounting.

Price from £10 complete.

Circle 8 *for further details.*

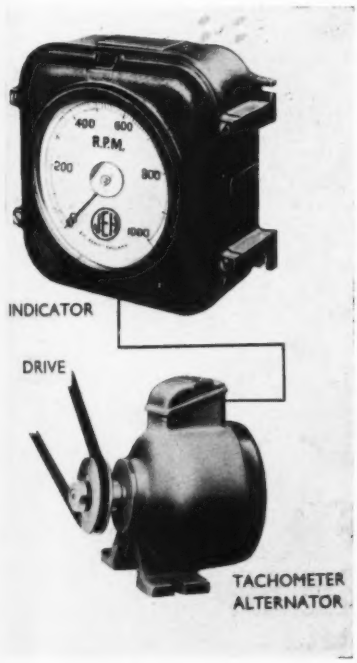
Revicon Tachometer Alternator

THE Revicon tachometer alternator is a speed indicating equipment, consisting of an alternator driven directly or through suitable drive from the shaft to be monitored, and an indicator on which the speed is shown.

The indicators are totally enclosed, oil, dust, and splash proof, and are designed for foot mounting with a shaft extension in any position for coupling to pinion, chain, V, flat or round belt drive.

The linear output voltage over a given speed range is continuously rated, and the equipment is suitable for operation directly on shaft speeds up to 3,000 r.p.m.

A full range of indicators is available from 4 in. to 12 in. diameter, near linear graduation; 270° arc; single or multiple as required. In addition, speed sensitive relays are available, arranged to operate under conditions of speed failure or variation from pre-set values, and are available in single and multiple designs to cover a wide range of application.



Revicon tachometer alternator.

Electrical Specification

Continuously rated at 3 watts a.c., output voltage 30 volts at 2,000 r.p.m. 20 pole stator. Stator resistance d.c., 11·25 ohms.

Mechanical Specification

Shaft size ¼ in. diameter. Free shaft extension 1 in. Pulley fixing ½ in. B.S.F. nut. Approximate size is 5 in. × 4 in. × 5¼ in. high.

Circle 9 *for further details.*

World's Largest Audio Amplifier

WHAT is claimed to be probably the largest sound or audio amplifier in the world is now under development by Gresham Developments, Limited.

With a finished weight of approximately 10 tons, it will have an output of 300 kilowatts. The frequency range of the sound output will be from 1 kilocycle to 5 kilocycles per second, with a low distortion of 5 per cent at full power, and a high signal-to-noise ratio of 40 decibels.

The output stage consists of four large, water-cooled Mullard transmitting valves in parallel push-pull and the driver stage comprises four water-cooled Mullard valves operating as cathode followers.

When installed, the amplifier may often have to work through several continuous 24-hour operations. Thus it has to have the utmost reliability and robustness, or in other words, long life with continuous operation, with the minimum of maintenance.

Specification

Output Power:	300 kW.
Audio Frequency Range:	1—5 kc/s.
Distortion at Full Power:	5%.
Signal-to-Noise Ratio:	40 dB.

Circle 10 *for further details.*

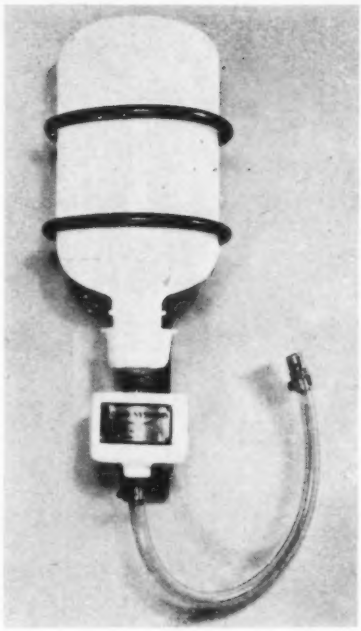
Liquid Level Controller

THE liquid level controller, model No. 614, manufactured and marketed by Liquid Systems Limited, can be used with all types of liquids wherever a constant level is required to be maintained.

The one gallon polythene bottle holding the liquid is fitted into a mild steel holder designed to carry the whole weight of the bottle without any strain being transmitted to the valve. The bottle holder is secured to the main bracket but can easily be removed to enable the unit to be fixed to the machine. This is accomplished by fixing two set screws through the bracket, slotted holes being provided to enable slight adjustments in level to be made.

The reservoir cup is aluminium (p.v.c. coated) and is fastened to the aluminium main bracket.

The valve is spring loaded to prevent loss of fluid when inverting the container, and opens automatically when the container is replaced in position in its holder.



Liquid level controller.

All valve parts are in stainless steel, any other parts coming into contact with the fluid being either stainless steel, polythene or aluminium p.v.c. coated.

The unit is supplied complete with 5 ft polythene tubing, two stainless steel hose connectors and worm drive clips; a brass adaptor is also provided for brazing to the tray of the machine.

Circle 11 *for further details.*

The Troidac

FOUR basic sizes of a new range of toroidal voltage regulators will be marketed, known as Troidac 2·5, Troidac 10, Troidac 20 and Troidac 40. Of these, Troidac 2·5, Troidac 20 and Troidac 40 are in production. The Troidac 10 will be available shortly.

All units are designed for a nominal ratio of 240/270 volts or 240/240 volts. Additional tappings are provided at approximately 25%, 50% and 75% of the winding for use with auxiliary transformers.

The Troidac 2·5, rated current 2·5 amp, maximum 3 amp, is of unusual construction in that the core and the winding, apart from the brush track, are encapsulated in polyester resin. This arrangement protects the winding against damage in the "back of board" version and provides a fully insulated and robust portable unit.

The Troidac 10 will also be a resin cast unit, whilst the Troidac 20 is air cooled.

The Troidac 40 is an oil cooled unit, rated at 40 amperes from 0 to 240 volts and 35 amperes from 240 to 270 volts. A single unit will provide approximately 9·5 kVA of control and a three gang version can be provided.

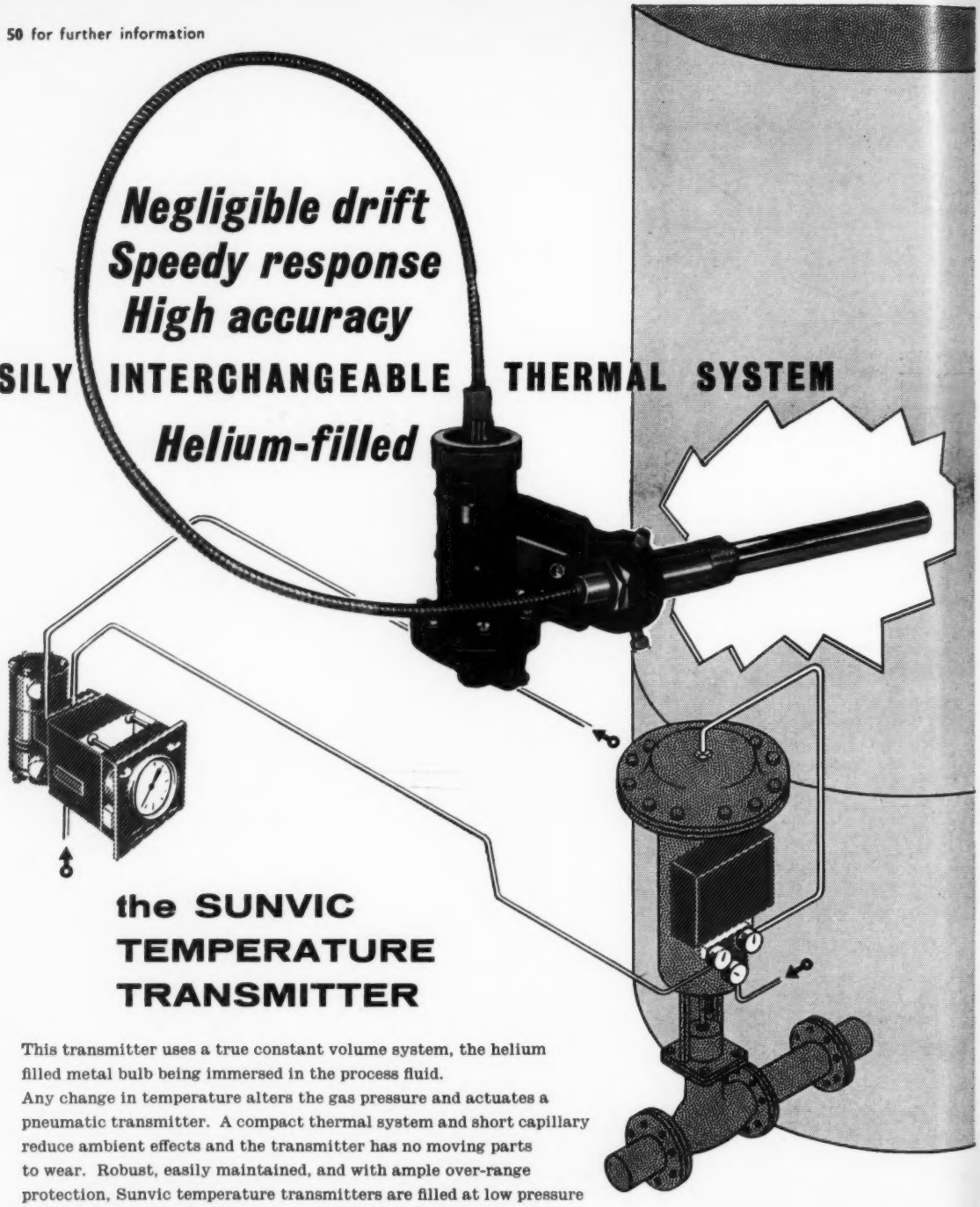
Circle 12 *for further details.*

Circle **50** for further information

Negligible drift
Speedy response
High accuracy

EASILY INTERCHANGEABLE THERMAL SYSTEM

Helium-filled



the SUNVIC TEMPERATURE TRANSMITTER

This transmitter uses a true constant volume system, the helium filled metal bulb being immersed in the process fluid.
Any change in temperature alters the gas pressure and actuates a pneumatic transmitter. A compact thermal system and short capillary reduce ambient effects and the transmitter has no moving parts to wear. Robust, easily maintained, and with ample over-range protection, Sunvic temperature transmitters are filled at low pressure and checked by mass spectrometer. Temperature spans: 50°F - 900°F; ambient limits—60°F to +200°F; Max. Temp. 1,000°F; Min. Temp. –328°F. Full information in Technical Publication 1331.

For a copy, please contact:

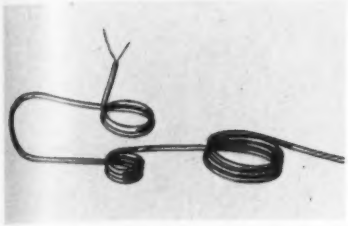
SUNVIC CONTROLS LIMITED, P.O. BOX ONE, HARLOW, ESSEX *Telephone: Harlow 25271*

SUNVIC
An A.E.I. Company

Not only instruments but complete instrumentation

for integrated monitoring, control and data handling of nuclear reactors and industrial processes

SC/78



Baker integral-sheath thermocouple.

The Baker Integral-sheath Thermocouple

THE Baker integral-sheath thermocouple was developed in order to satisfy a requirement for a high-temperature precious metal thermocouple assembly, which is both flexible and of small diameter. The assembly comprises an outer, flexible metallic sheath having an external diameter of approximately $\frac{1}{16}$ in. surrounding two wires comprising the thermoelements. The thermoelement wires are insulated from one another and from the sheath by means of a compressed pure oxide refractory powder, and the resulting assembly is flexible enough to permit being formed round a diameter, equal to four times that of the assembly, without damage.

The integral-sheath couple has already found application in at least one type of high temperature nuclear test loop, where the requirements of flexibility and small dimensions precluded the use of conventional assemblies.

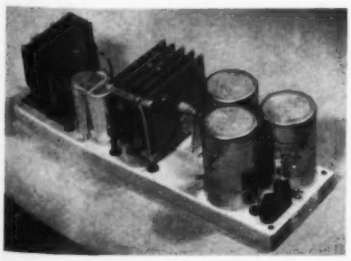
A modified assembly of this type is already under development, and consists of an outer metallic sheath (which in addition comprises one element of the couple) surrounding a centrally located single wire which comprises the second element. This co-axial type, also insulated with a compressed pure oxide refractory powder, is expected to have an external diameter in the order of $\frac{1}{32}$ in.

The twin-element wire type is currently available in several standard forms.

Circle **13** *for further details.*

High Current Constant Voltage D.C. Power Supplies

THE circuit of the Advance constant voltage d.c. power supplies consists of an Advance constant voltage transformer followed by a high efficiency semi-conductor rectifier and high capacitance filter. The components are mounted on a chassis which is suitable for securing to a standard 19 in. rack panel if desired. This circuit contains no moving parts and requires no manual adjustments or routine maintenance. The electrical circuit is insulated from ground, permitting operation at either polarity. Similar units can be parallel or series connected. Thus, these power supplies are suitable for transistorised equipment providing the low voltage and high current d.c. supply required.



D.c. power supply unit.

Specification

Input Voltage:	200, 215, 230, 245 volts, ± 15%, 50 c/s.
Output Voltage:	Stabilised within ± 1% at full load, with supply voltage variations up to ± 15%. The stabilisation at half full load is generally better than ± 1·5%.
Ripple Voltage:	Less than 1·5% R.M.S. of total output volts.
Maximum Temperature Rating of Units:	Units must be situated so that adequate free ventilation is ensured for the rectifier. Maximum operating temperature 55 C with adequate ventilation.

Circle **14** *for further details.*

Teddington Safety Shut-down Valves

Two new solenoid valves have been added to the range of protection equipment manufactured by Teddington Industrial Equipment Limited for engines and gas turbines.

They are intended for use with automatic protection switches or panels in order to shut down the engine in the event of abnormal operating conditions.

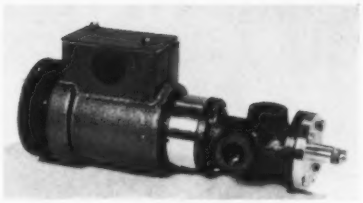
When, as is usually the case, protection equipment is arranged to stop an engine in the event of loss of lubricating oil pressure, the safety switch must be isolated during the starting sequence, so that normal working pressure can be established.

The normal practice is to switch the protection equipment in after the engine has been started, but where the shut-down device is maintained in the "run" position electrically, means must be found for holding the device open until the protection equipment is alive.

The first of the new Teddington valves Type YF/R has been designed specially for this purpose. It is energised to open so that in the event of electricity failure the engine will be stopped automatically—a particular advantage when applied to the protection of generating sets—but is fitted with a manual lever which holds the valve open mechanically during the starting operation and is returned to the automatic position by hand when the protection equipment is brought into circuit.

The valve is then held open electrically and is thus free to cut-off immediately it is de-energised by the protection equipment under fault conditions.

Having a straight-through $\frac{3}{8}$ in. ported body, the valve may be used to cut-off the fuel supply to the injection pump, or in the case of gas turbines, to the burner. Alternatively, it may be used for the control of hydraulically operated governors.



Teddington Type WU solenoid valve for viscous oils.

The other new valve Type WU has been introduced for applications where it is inconvenient to use the normal shut-down valve, which has to be re-set after operation. It is of the balanced, slide pattern, and has a 3-way body which permits it to be used either for cut-off or diverting service. When used as a cut-off valve, it can be arranged to open when energised or to close when energised, merely by plugging the appropriate port.

The valve has been designed for the control of fuel oils and other fluids at viscosities up to 1 000 seconds Redwood No. 1, at pressures ranging from 0 to 300 p.s.i. and is equipped with an interlocking switch operated by the valve spool to provide a remote indication of valve position.

Apart from its normal use as a shut-down valve, this new model has already been used for other applications such as the protection of hydraulically operated clutches.

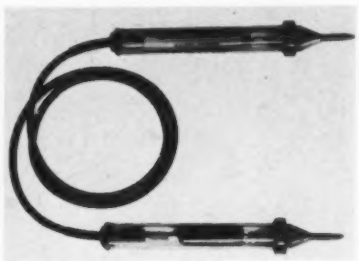
Circle **15** *for further details.*

New Potential Indicator

A NEW potential indicator, called "The Eversafe" has been produced which is claimed to be reliable and inherently safe at all times.

Accidents caused by faulty potential indicators, usually known as electricians' test lamps, have been mentioned on many occasions in the annual report of the Senior Electrical Inspector of Factories, and the manufacturers believe that the new instrument which has the following advantages will prevent these.

1. All components and connections are hermetically sealed in a thermo-setting resin which is non-tracking and unaffected by heat and acids. The material is transparent and allows for inspection at any time.
2. The unit is designed so that no repair can be made and no broken unit used, and thus remains safe throughout its life.



Eversafe potential indicator.

3. The indicator is a neon lamp with wire tails, taken out at the opposite end of the tube, giving a long leakage path.
4. It has no springs or screwed contacts, every connection being solidly made.
5. It uses a high value resistor in each prod and even in the event of failure of insulation in the cable connecting the two prods, the current is limited to a value which will not produce a shock hazard.
6. The unit is designed to operate on potentials from 250 volts to 650 volts.
7. It is light and small and can be carried with the cable around the operator's neck and the prods in his breast pocket.

Circle 16 *for further details.*

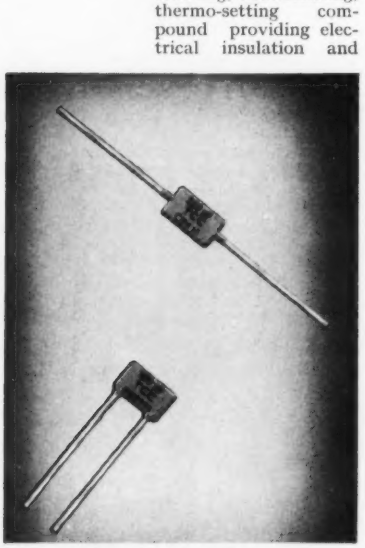
Miniature Protected Silvered Mica Condensers Types—CSM 15 & CSM 15 s

T.C.C. have introduced the following ranges of high stability, low-loss and close tolerance mica condensers.

Two methods of assembly terminations are offered, axial Type CSM15 for in-line wiring and side mounting, CSM 15 s making them ideally suitable for incorporation into printed circuit panels, transistor, hearing-aid and sub-miniature assemblies.

Capacity Range:	10 pF to 220 pF.
Capacity Tolerance:	±20%, ±10%, ±5%, ±2%, ±1% or ± 1 pF minimum.
Rating	350 V d.c. working. 1,000 V d.c. test.
Power Factor:	Less than 20×10^{-4} at 1 Mc/s.
Temperature Coefficient:	+ 5 to + 50 parts per million per °C.
Temperature Rating:	−70°C to + 100°C.
Insulation Resistance:	Better than 100,000 megohms.
Finish:	Insulated—Special non-cracking, heat-resisting, thermo-setting compound providing electrical insulation and good protection against the ingress of moisture at temperatures up to + 100°C.
Weight:	0·35 grams.
Terminations:	Solder coated strip. 0·04 in. wide × 0·012 in. thick.

Circle 17 *for further details.*



Miniature mica condensers.

Tube Tester for Non-magnetic Metals

THE C.N.S. tube tester is designed for rapid location of faults in tubes of non-ferrous metal or stainless steel and for locating corrosion of condenser tubes in steam boiler installations. The equipment is so laid out that the testing can be carried out by untrained personnel once the initial setting has been made by the supervisor.

The instrument shows up three types of fault:—

(a) Cracks, inclusions or superficial faults.
(b) Local changes in wall thickness.
(c) Corrosion.

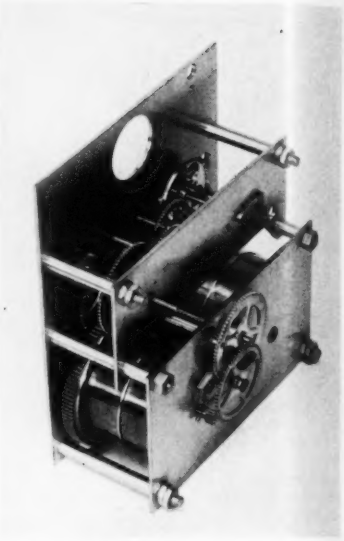
The equipment consists of a probe or probes containing search coils which are passed around or through the tube specimen. The proximity of the metal occasions certain resistive and inductive changes in the coil characteristics which remain constant as long as the tube metal is consistently homogeneous and free from faults. The probe coils are balanced to give a zero on a meter by resistive and inductive variables inside the main unit. The coils are balanced in a good specimen of the material or in a known good section of the tube itself. The testing is carried out by sliding the probe along the tube and as each fault becomes scanned by the probe the meter zero balance is upset and an indication is given on a meter needle, a warning light and by the ringing of a buzzer alarm. With a high speed alarm relay, testing can proceed at 100 feet per minute.

The operation of testing is assisted by the alarm system which is adjustable in sensitivity so that the user may, by judicious use of the setting, pass over very small faults which would not impair the function of the tube and reject only where the faults are of significant size. In practice, it has been found that cracks equal in size to 5% of the tube wall thickness are easily detectable and a 2½% step in wall thickness gives a pronounced signal.

When the equipment is used for checking for corrosion in condenser tubes, the probe is first set to balance in a known good specimen of the original material. This balance is set by variable resistance and inductance within the unit and upon probing the condenser tubes any corrosion will instantly produce an out-of-balance effect which will sound the alarm. The existence of a known standard specimen is necessary where there is corrosion which may be equal in extent throughout the length of the tube.

Different materials have different resistivity and permeability, and these require that the equipment shall operate on various frequencies so that maximum penetration and sensitivity shall be available. To this end the instrument has a frequency switch giving four ranges which are sufficient to cover all materials in normal use. Tubes with exceptional wall thickness may also need a changed frequency to achieve full penetration and where the material is particularly thick-walled and of low resistivity and permeability, then probing is desirable both from the inside and the outside.

Circle 18 *for further details.*



Clock with Tensator B motor spring fitted.

Clock with Tensator B Motor Constant Torque Spring fitted

THE mechanism, developed for a nationalised industry, showed improved performance with the incorporation of the Tensator B motor constant torque spring in the place of the barrel spring. The efficiency was 45% against 25% in the standard clock and timekeeping errors were reduced by approximately 90%. The Tensator spring does not suffer from intercoil friction, and requires no lubrication.

Circle 19 *for further details.*

'Emiway' System Aids Automatic Processing

A NEW control system for automatic weighing has now been developed by E.M.I. Electronics Limited.

It is known as the 'Emiway' system and can be fitted to most types of scales, making possible the accurate control of any number of weighing operations.

The weight of materials to be discharged from storage bins or hoppers can be set-up on dials or programmed on punched cards or tape. Automatic switching from fast to slow feed is provided. The system ensures accuracies in the region of 1 part in 1,000 of the 360 degrees of a scale dial movement.

Automatic weighing of containers enables the tare weight to be recorded before material flow starts, and ensures that the net weight remains constant.

When required, remote indicators can be provided enabling the weight on the

scale dial to be displayed simultaneously at any number of other points.

Data such as time, date, type of material, source, destination and costs can be recorded automatically for stock control and accounting purposes, by electric typewriter or teleprinter, card or tape punch.

The basic equipment consists of five units:—

1. The scale transducer.
2. Analogue to digital conversion unit.
3. Print out decimal to binary conversion and control unit.
4. Power units.
5. Remote display.

A transducer is fitted on the back of the scale which is coupled directly to the pointer shaft. Remote from the scale, in any convenient location, is the main cabinet, including the servo equipment, digitiser (which converts the shaft angle to an unambiguous digital code representing the angular displacement) and other units.

Decoding of this digital information is performed by an electric decoder, which works at very high speed and, unlike the relay type of decoder, can accurately follow the rapidly varying movement of a scale pointer in either direction.

The output may be continuously displayed, and by means of coincidence circuits, the decimal output from the decoder can be "caught" at a predetermined setting, and made to control, say, the feeding mechanism of the material being weighed. An unlimited number of such circuits can be added and set as required to perform a number of different functions at different weights, (e.g. coarse and fine feeding, of several different materials, on a cumulative weighing system).

A delay network may be added which assures that the scale has come to rest before further action, such as print-out or adding another ingredient to the weight, takes place.

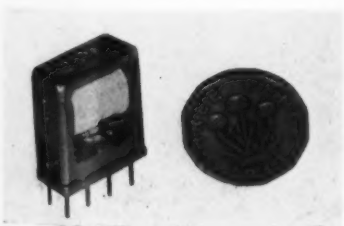
In the print-out equipment, the decimal outputs are scanned in sequence, the scanning system stopping momentarily on each digit to be printed, allowing sufficient time for a teleprinter to print that figure, before searching for the next digit.

Circle 20 *for further details.*

Clare 'F' Relay

C. P. CLARE LIMITED, a company in the Elliott-Automation Group, announce that they have now commenced the manufacture, under licence from C. P. Clare & Co., Chicago, U.S.A., of the Clare 'F' relay.

The hermetically sealed relay weighs 0·52 oz and measures 0·875 in. × 0·8 in. × 0·396 in. It has 2 contacts rated for 3 amp at 28 V d.c. and 115 V a.c. The pick-up time is 3·5 msecs and drop-out time 1·5 msecs. The nominal operating power is 250 mW.



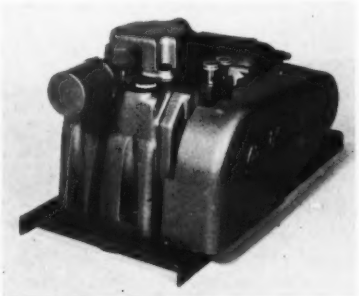
Clare 'F' relay with cover removed.

To meet military requirements, it has a temperature range of −65 to +125°C. Due to the balanced armature construction, the rigid frame and high contact forces, it will stand a shock of 65 g for 11 msecs and severe continuous vibration.

Production is initially concentrated on the 26·5 volt model having a minimum operating current of 19 mA and a coil resistance of 675 ohms. Other models in the voltage range of 6·3 to 110 V will be introduced in the near future.

The relay is designed especially for one-tenth inch grid printed circuits. Terminals of the glass-to-metal header are spaced two tenths of an inch apart in two rows likewise two tenths of an inch apart. Solder hook and 3 in. lead terminals are also available. The relays can be supplied with A.I.D. or A.R.B. approval.

Circle 21 *for further details.*



High vacuum rotary piston pump.

High Vacuum Rotary Piston Pumps

THE photograph shows the "Genevac" single stage high vacuum rotary piston pump which is in 2, 4, 8 and 12 ft³/min. capacity with an ultimate vacuum of less than 0·005 mm Hg. The double stage model is in 2, 4 and 6 ft³/min. capacity with an ultimate vacuum of less than 0·0002 mm Hg. The design permits of higher pumping speeds at 100 microns and the pressure rise is less than 0·5 mm Hg with maximum ballast. The necessity for oil changes is reduced to a minimum due to the oil circulation filter system.

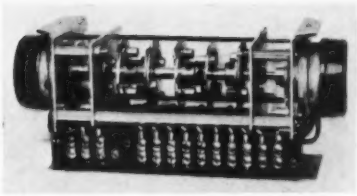
Circle 22 *for further details.*

"Rodene" Sequence Controller

THE RODENE ELECTRICAL COMPANY LIMITED have developed a new synchronous multi-circuit timer which can be driven clockwise or anti-clockwise.

This effect is achieved by fitting two "Rodene" self-clutching motors. When one is energised it automatically clutches on to the camshaft and drives it in one direction unimpeded by the other motor which remains un-clutched. Similarly energising the second motor drives the camshaft in the reverse direction.

The unit can have up to 24 fully adjustable twin cams, and was first produced to raise and lower the output of a set of pumps. It is also made with the two motors at one end (one being shaded to give reverse rotation), and with a variable resistor fitted to the free end of the camshaft which can be connected to re-balance a bridge when the correct number of heaters, pumps or the like have been switched on, to give the rate of correction called for by the condition that un-balanced the bridge.



"Rodene" sequence controller.

The unit is normally of metal but can be of non-inflammable transparent plastic. A dial showing the position of the camshaft can also be fitted.

Circle 23 *for further details.*

Optical Comparator Type 801A

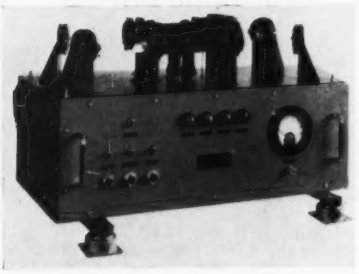
WHENEVER a process produces a change in the optical properties of the medium, an optical comparator can be employed. The Type 801A is the latest version of an instrument originally developed by Messrs. Electro Methods Limited, in conjunction with the Sunbury Research Station of the Anglo Iranian Oil Company. The primary purpose of the instrument is the continuous supervision of the boiler feed water in an oil cargo tanker or power station, but the instrument is by no means limited to this particular problem.

Since even a very small leakage of oil has a cumulative effect in time and must not pass unnoticed, the instrument is made sensitive to very small contaminations and a figure of two parts per million is chosen as a limit of sensitivity. This limit is easily achieved, since the instrument can readily detect half of this amount.

The instrument is built in a metal box having two compartments. The top compartment contains the optical unit comprising two cylindrical chambers, each terminated with fused silica windows in either end, together with a light source, reflecting mirrors and photo-cells. Two light beams derived from a common source are reflected by a system of spherical mirrors and are focused on two vacuum type photo-cells arranged in a ratio bridge circuit. The supply to the bridge is stabilised and the bridge temperature compensated. One of the liquid chambers is supplied with a reference solution, while through the other chamber the supervised liquid is passing continuously.

The minute globules of oil suspended in the condensate scatter the light beam and produce sufficient unbalance of a photo-sensitive bridge for the instrument to operate.

The bridge effects, therefore, the comparison of the two light beams derived from a common light source passing through the media to be compared. The inequalities caused by difference in light absorption or scattering in the test sample



Optical comparator 801*A*.

changes the conductivity of the corresponding cell and gives an output from the bridge which is amplified by a magnetic amplifier contained in the subsidiary circuitry in the bottom compartment. The sensitivity of the instrument is expressed in the percentage of contamination necessary for the instrument to operate an alarm system.

The meter is calibrated in percentage and the instrument is pre-set to operate the relay when the current in the signal winding of the magnetic amplifier reaches ½ f.s.d. of the meter. Thus the percentage indication of the meter is arbitrary and if necessary may be interpreted in terms of a suitable unit. The instrument is calibrated by passing through the test chamber samples of water with a known oil content, and adjusting the gain of the amplifier to give the desired response.

The indicating instrument may be substituted by a recorder or remote indicator. The equipment is made insensitive to disturbances of short duration; e.g., the passage of air bubbles, and small particles or momentary turbulence, by making the time constant of the amplifiers sufficiently long. The failure of the light source, which is totally enclosed, is indicated by a light on the panel of the instrument which is actuated by a relay connected in series with the light source filament.

The detector is placed near the possible source of contamination, in order to indicate leakage before the contamination reaches other parts of the system or becomes diluted. Further applications for the instrument are the continuous colour supervision of liquid distillate, or, with a suitable modification, the monitoring of gas stream. Special colour filters of polarised light can be used in order to increase sensitivity to a particular property of the medium.

Weight:	122 lb (55·5 kg).
Maximum Sensitivity:	Such that with oil content in water of 2: 1,000,000 the monitoring meter reads 50% of full scale deflection.
Alarm Accuracy:	The alarm circuit operates and clears within the margins when the monitoring meter reads 50% and 46%.
Zero Setting Accuracy:	Better than 1%.
Zero Stability:	Within 2% of monitoring meter full scale deflection after 1 hour warming-up period.
Alarm Socket Output:	6 volts, 5 amperes at supply frequency.
Solenoid Valve Socket Output:	5 amperes at supply voltage and frequency.
Maximum Temperature of Flow:	80°C.
Maximum Pressure of Flow:	5 lb/in².
Maximum Ambient Temperature:	50°C.
Power Supply Required:	200-250 volts, 6·0 amperes, 50 c/s ±1%.

In cases where solid particles are present in the flow to be monitored a separator will be required.

Circle 24 *for further details.*

The Sandmaster

THE Sandmaster consists of two units:—

(a) an indicator (10 in. × 8 in. × 6 in.).

(b) a cylindrical probe (10 in. long, 2 in. diameter).

The cylindrical probe is fitted with a

Sandmaster moisture meter.

p.t.f.e. sensing head, which prevents the sand from sticking to it. The probe is completely water tight. The probe is connected to the indicator by a 6-core cable that must not be altered in length once the instrument has been calibrated.

The Sandmaster measures the moisture content of the material about the p.t.f.e. sensing head and utilises a capacitance measurement at very high frequency (over 100 megacycles per second) as the working principle. It is the dielectric property of sand which is used and this is proportional to the moisture content.

The indicator must be connected to an a.c. mains supply which may be within the range of 200-260 V but with a frequency of 50 cycles. Variation in voltage is compensated for within the instrument but a deviation from the stated frequency of 50 cycles will upset the accuracy of the readings.

The moisture readings are indicated by a needle which moves over a scale divided into 100 divisions which can be apportioned to the operating moisture range, e.g., 0 to 10·0%, 1·0 to 11·0%, 2·0 to 12·0%, etc.

A paper scale of "water addition" may be attached with the "moisture scale" showing number of gallons or lbs of water required to be added, corresponding to each division of moisture content in the sand.

In Great Britain the initial adjustments are made by the technical staff of Shaw Moisture Meters and there is no charge for this service.

The probe may be sited in either a storage hopper from which sand is withdrawn or a weigh hopper.

The cost of the Sandmaster is £200 (delivered). It is available on rental at £3 per week. (Minimum period of 1 month.) The rental for one month will be deducted from the price if the instrument is purchased.

Circle 25 *for further details.*

Tape Loop Adapter for Solartron Data Handling Equipment

THE quick, easy conversion of the Solartron magnetic tape recorder and reproducer for data handling by means of the new tape loop adapter to an accurate continuous loop recorder/reproducer will double its flexibility.

The continuous loop reproducer is unique for the accurate, detailed and repetitive spectrum analysis of recorded information. Some examples include rocket engine tests, wave analysis by time compression, well-drilling investigations and medical cardiographic studies, telemeter signals and large scale industrial process monitoring.

The tape loop adapter is attached to the front of the equipment in place of the tape reels. No major modification is necessary. A screwdriver is required only for the initial installation. Afterwards the adapter is removed or attached quickly and simply.

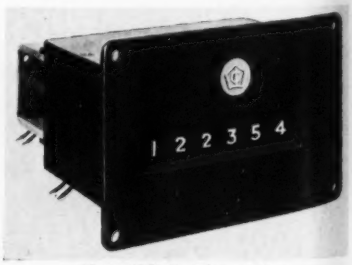
The upper and lower arms are adjustable to accommodate loop lengths from 2 to 26 ft. Three models for standard tape widths of ¼ in., ½ in. and 1 in. A switch is installed on the back plate of the recording instrument to allow the electrical stop-action of the reel follower arms to be disabled when loop operation is required.

Circle 26 *for further details.*

Electro-magnetic Counter with Electric Reset

TYPE 100 electric counters can now be supplied for delivery with electrically operated resetting facilities.

This takes the form of a solenoid mounted at the rear of the case, which when momentarily energised, operates the resetting mechanism to return the counter reading to zero. The counter incorporates a balanced escapement mechanism. One of the many advantages of this form of resetting is that a number of counters can be reset to zero at the same time by operating a push-button switch, which can be situated remotely from the counters.



Type 100 *electric counter.*

Another feature of this counter is that it can be electrically reset when operating without causing any damage to the counter mechanism.

The counter can be supplied with a standard range of coils for both a.c. and d.c. supplies, and the unit price for models operating on a.c. supplies is £10 17s. 0d., and on d.c. supplies £10 2s. 0d.

Circle 27 *for further details.*

The Lindars Timer-Counter Unit

LINDARS AUTOMATION LTD., a subsidiary of Dunford & Elliott (Sheffield) Ltd., have recently developed a small and compact combined "events per unit time" and "time per unit event" counter.

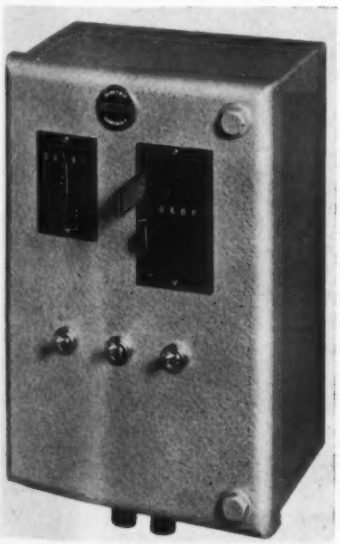
Basically, the unit consists of an electrical pre-set counter, an electrical resetting counter and a 1 revolution per second synchronous motor giving 10 impulses per revolution. The required time may be set on the pre-setting counter up to a maximum of 999·9 seconds and on expiration the number of events will be displayed on the resetting counter. Alternatively, should it be required to time a number of events then the number of events may be pre-set and when completed the elapsed time is displayed to a $\frac{1}{10}$th of a second.

It is necessary for the events to be in the form of impulses received from, say, a micro-switch, photo-cell, etc., and may be up to a maximum of 10 per second. To ensure accuracy, first pulse suppression is incorporated, the first pulse starting the timing but not registering on the counter.

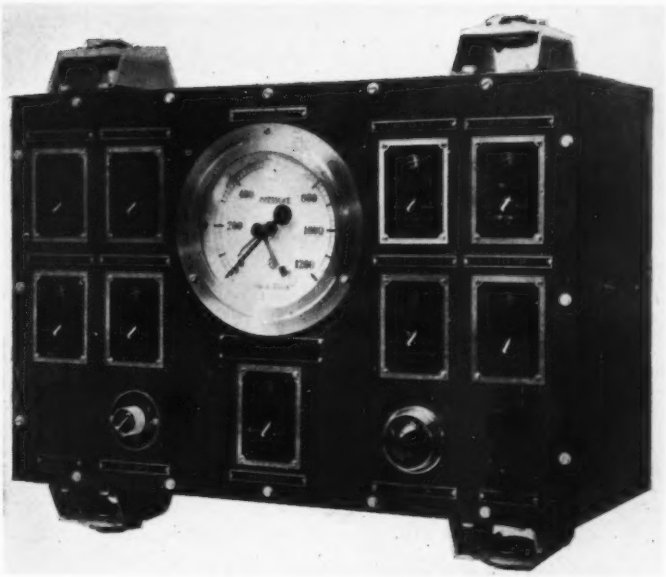
The obvious advantage of this unit over the more conventional stop watch method is that the count remains indicated and as no reading "on the fly" is necessary human error is entirely eliminated.

Possible uses for this unit include accurate measurement of shaft speed, process timer checking, rate of package flow, vehicle rate check, etc.

Circle 28 *for further details.*



Timer counter unit.



Compressor protection panel for surface installations.

Protection Equipment for Compressors

TEDDINGTON INDUSTRIAL EQUIPMENT LIMITED have developed, with the assistance of the N.C.B. and leading compressor manufacturers, a system of comprehensive protection equipment which provides completely automatic supervision for all types of compressor.

The equipment consists of a panel mounted on the compressor and, for underground use, a flameproof indicating unit, rotary switch and alarm bell.

The flameproof indicating gear usually employed is the Davis F.I.U. indicator which houses six indicator circuits employing intrinsically-safe a.c./d.c. relays and lamp indicators and two step-down transformers for the low-voltage protection and indicating circuit.

The Davis rotary switch used with this is another flameproof component which incorporates two time delayed switches, one to permit the compressor to establish normal oil pressure before the shut-down circuit comes into operation and the other to give protection against a power failure. A third switch enables the compressor to be shut down by hand when required. Warning is given by an alarm bell fed from the intrinsically-safe circuit.

The Teddington protection panel fails safe in the event of fault or damage and this ensures that the compressor cannot run unprotected. If any damage occurs, or any fault develops in the sensing systems, the protection switches will immediately break circuit and the warning or shut-down circuit will operate to call attention to the fault.

The contacts cannot weld and thus prevent the circuit being broken, since the current they carry is too small to generate any heat. If the contacts become dirty or tarnished and prevent the circuit being made, then it will be impossible for the compressor to run longer than 20 seconds after the rotary switch has been turned on or, alternatively, the alarm will sound continuously.

The thermal system of the temperature switches is exceptionally stable, but as an added precaution has been so designed that if any slight drift does take place, shut-down will occur earlier and will once again call attention to the fault. This makes the shut-down system completely foolproof as shut-down can never occur too late—the equipment will *over* protect rather than *under* protect. The complete equipment will also fail safe by shutting down the compressor automatically in the event of mains failure or earth fault.

For surface installations, the separate indicator unit is replaced by a series of latched fault indicators in the panel itself. These are interlocked so that only the fault which caused the compressor to stop is indicated. Built-in audible and visual alarms are also fitted when specified.

The panels can be used either on line or low voltage.

Circle 29 *for further details.*

Calculator for the Paper Trade

THIS calculator, which is of the dial type with a movable cursor, is designed for conversion in one operation from the metric to the English system of weights and measures and vice versa. All conversions and paper sizes are provided for in the scales, and no manual or mechanical calculations are required.

In addition to the metric and English conversions, the Smith & McLaurin calculator can be used for cost conversions, multiplications and divisions and percentage calculations.

The calculator is made of stout varnished board with a polished centre stud and cork tipped cursor.

Circle 30 *for further details.*

Circle 51 for further information

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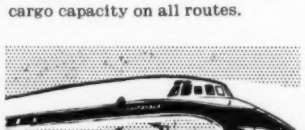

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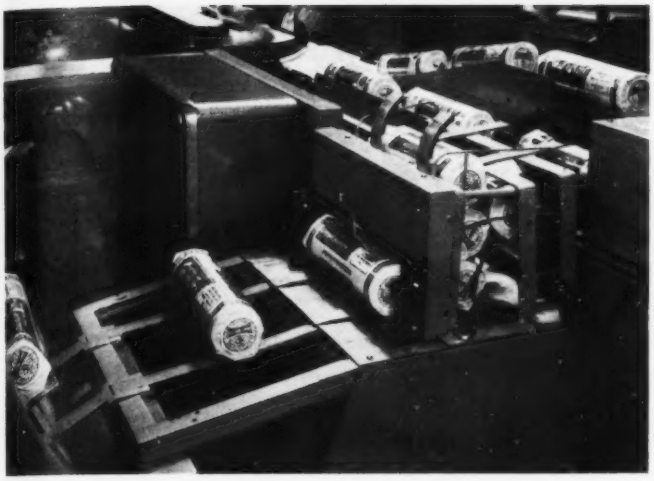


Electroma high speed check weigher.

Universal Eput Meter Type 7360

THE Beckman/Berkeley Universal Eput Meter Type 7360 is now available through the United Kingdom selling and servicing agents Winston Electronics, Limited.

Applications include counting, time interval measurement, events-per-unit-time measurement, pressure, flow measurement, timing relay, shutter action, tachometry, telemetering, events counting, ratio measurement, high and low frequency measurement, stability checking, secondary frequency standardisation, phase measurement, precise event timing, relay and switch timing, timing generator, ballistic, viscosity and elasticity measurement.

Input Impedance:	10 MΩ. Choice of direct or a.c. coupling.
Input Step Attenuators	100:1, 10:1, and 1:1.
Input Trigger Controls:	Adjustable. Measurements possible in presence of noise signals.
Output Clock Pulse from Time Base:	A secondary standard for calibration or a master time base for tandem operation of several units.
Binary-coded Output Information from each Decimal Counting Unit (D.C.U.) :	This operates Berkeley digital recorders, new inline readouts, or data converters to drive I.B.M. punches, electric typewriters, teleprinters and analogue strip chart recorders.

The input channels are provided with step-attenuators in addition to trigger level controls. The use of trigger level instead of gain controls enables trigger levels to be adjusted to precise points on input signals for the accurate measurement of complex waveforms and provides discrimination against noise signals. Timing signals come from a highly stable crystal controlled oscillator followed by an exact divider chain.

All measurements are in direct digital display.

Circle 31 *for further details.*

The Electroma High Speed Check Weigher

THE weigher employs a combination of bridge and force balance techniques, by means of which the effects of vibration and temperature variations are cancelled out. As a result, the high performance of 120 weighs a minute at 0·2% accuracy are actually achieved in factory conditions.

The tendency for displacement of the platform is detected by velocity and position transducers, and counteracted by an electromagnetic force; hence no appreciable movement in fact occurs, inertia effects are minimised, and the weighing time extremely small. The output from the transducers, after amplification, is applied to the discriminator, which decides whether the object is correct over or under weight.

The handling equipment, comprises a marshalling system, a magazine, the loading mechanism, the reject system, and an off-loading conveyor. The movement of the loading mechanism is sinusoidal so that at the instant of pick-up and release, velocity is zero, thus reducing inertia effects.

Provision may be made for counting, indicating trend, and recording results. It is also possible to incorporate feedback systems whereby the weigher can control dispensing operations, or processes that effect ultimate weight.

At present the weigher is finding application in the packaged food industry, but development with can handling is well advanced, and it will soon be possible to handle cans at approximately 180 per minute. It is also suitable for cigarettes, and any small manufactured article.

Circle 32 *for further details.*

Process Timer

A NEW series of economically priced electronic process timers known as series PCT.1 are available in six basic forms depending upon the required time range and can be connected together to provide multi-stage timing control for complete processes.

The six basic models are designed to provide time ranges of :—

(a) 0·1 to 1·5 seconds.
(b) 0·3 to 5 seconds.
(c) 1 to 15 seconds.
(d) 3 to 50 seconds.
(e) 10 to 150 seconds.
(f) 30 to 500 seconds.

Each main time range is sub-divided into "Long" and "Short" ranges selected by a switch and a continuously variable control is provided for accurate setting of the required time interval. The units have a repeat accuracy of ±1% on a stable supply and variations in supply voltage of −15% to +10% will not cause more than ±5% change in the set time interval.

The process timers are housed in a substantial cast light alloy case which is designed for wall or base-mounting. Suitable sealing arrangements are provided on the detachable covers to prevent the ingress of dust and moisture. The timing controls are mounted on the front of the case, the time setting control being provided with a scale calibrated directly in seconds. The timers are designed for 200/250 volts or 110/115 volts, 50/60 c/s single phase supplies.

All timers in the range are priced at £11 14s. 0d. and are available ex-stock.

Circle 33 *for further details.*

Syncro-pointer

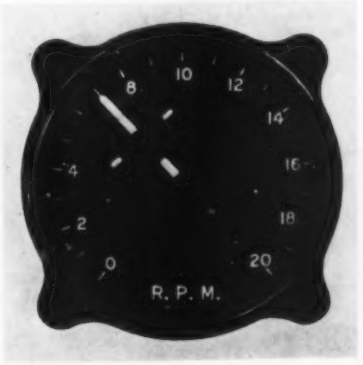
THIS form of instrument presentation incorporates a small "Syncro" pointer mounted on the axis of the main instrument pointer and geared in such a manner as to complete one revolution in the same rotational direction as the main pointer between each graduation line (or "block") on the instrument dial.

This enables the presentation of full scale reading on one radius on the dial.

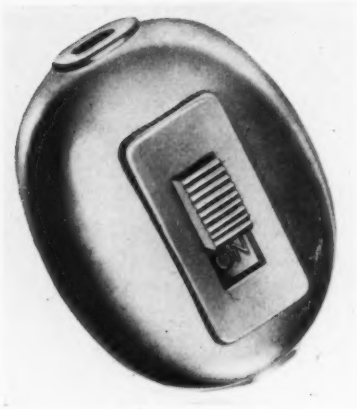
The radius of the Syncro-pointer is such that a considerable magnification of the scale length between the blocks on the dial is possible. In the case of a 20,000 r.p.m. indicator this could amount to about eight times.

In another arrangement, the Syncro-pointer could be geared up much more and be used purely as an indicator of increase or decrease of r.p.m. by the fact that it will rotate quickly in either direction immediately there is any change of r.p.m.

Circle 34 *for further details.*



Syncro-pointer.



Miniature line cord switch.

Miniature Line Cord Switch

A MINIATURE line cord switch has been designed for use with small desk fans, table lamps and lighting fittings.

The features of this design are the clear indication of "off" and "on" and the snubber type cord grip.

This switch has been designed to meet the demand from manufacturers of table lamp and lighting fittings who need a small, attractive switch, available at a reasonable price, with the two features mentioned above.

The Catalogue No. is S.952. The rating is 1 amp, 250 volts a.c.; 0·25 amp, 250 volts d.c. The list price is 2/- each and small quantities are available for delivery from stock.

Circle 35 *for further details.*

Stationary Hydrovane Air Compressors

Two new stationary hydrovane air compressors have been added to the range manufactured by Alfred Bullows & Sons Limited.

The first of these, the 200SR9501 has an output of 95 c.f.m. at 100 lb/in² and is mounted on a 6 ft × 2 ft horizontal air receiver. It is fitted as standard with a water-cooled oil cooler and the water flow is controlled thermostatically. The price of this unit is £475 plus 20%. An air-cooled oil cooler can be supplied at an extra cost of £30 plus 20%.

Stationary hydrovane air compressor.

The second unit is the 250SR12001 which has an output of 120 c.f.m. at 100 lb/in² and which costs £525 plus 20%. This unit can be supplied with an air-cooled oil cooler at an extra cost of £40 plus 20%.

Delivery of both units is at present six months.

Circle 36 *for further details.*

Three Digit Voltmeter

THE three digit model D101 voltmeter covers the range of 0·01 V to 999 V d.c. with automatic ranging, polarity and decimal placement and with an accuracy of 0·1% on any of the three ranges which are 0·01 to 9·99, 10·0 to 99·9, and 100·0 to 999·0 volts d.c. The average reading time is 0·7 seconds.

The basic principles employed in the voltmeter can be used for measuring ratios, currents and for analogue-to-digital conversion.

In operation, the input voltage is compared to the voltage from a Kelvin-Varley potentiometer and any difference actuates stepping switches until a balance is achieved, enabling the measured voltage to be presented digitally in the form of ⅜ in. high illuminated numerals in a 1¼ in. by 5½ in. display area. The reference voltage is from a bank of mercury cells. Stability is achieved by the use of a transistorised amplifier and high grade choppers, the accuracy of the instrument being unaffected by mains variation. Printed circuitry has been extensively used to ensure reliability.

The instrument has been adapted so that a printing device can be coupled to it, and a printer is at present under development. It is also possible to have a remote read-out so that the indicator unit can be located in any suitable position, if necessary at a distance from the voltmeter or other digital instrument. An a.c. to d.c. converter is also under development by Ferranti Limited, for use in conjunction with the three digit voltmeter.

The instrument is contained in a bench style cabinet, measuring 17 in. by 13 in. by 10½ in. high. Weight is 50 lb approximately.

Applications for the three digit voltmeter exist in the fields of automatic testing and monitoring, and wherever information can be presented in the form of a voltage. Examples of its use in production control are voltage measurement of batteries and for measuring thickness of materials by using voltages as parameters.

Circle 37 *for further details.*

Carrier Deviation Meter

The TF 791D is the latest model in the Marconi Instruments series of direct-reading f.m. deviation meters. Suitable for both communication and broadcast systems, it has four deviation ranges of 5, 25, 75 and 125 kc/s full-scale, and a modulation frequency range of 50 c/s to 35 kc/s. The calibrated carrier frequency range extends from 4 to 1,024 Mc/s; freedom from microphony is ensured by the crystal lock facilities, which bring the internal f.m. noise down to −55 dB relative to 5 kc/s deviation, allowing reliable measurement of f.m. hum and noise in transmitters for v.h.f. sound broadcasting and mobile close-channel working. To aid measurement of a sym-

Three digit voltmeter Type D101.

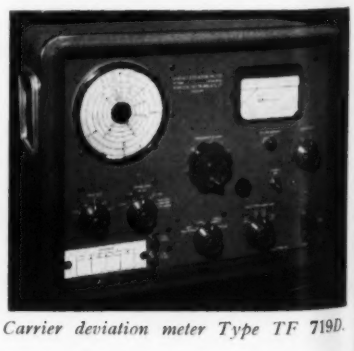
metric modulation, positive or negative deviation is displayed at the turn of a switch without the need for returning.

The local oscillator operates on harmonics over six of its eight bands; this avoids the danger of frequency pulling at the higher frequencies and ensures positive locking at any harmonic frequency of crystals within the relatively small fundamental range 2 to 10 Mc/s. Crystals up to a maximum of four, can be supplied to suit any specified carrier frequencies, and are selected in the instrument by a switch. Where the crystal oscillator harmonic power is adequate, the local oscillator can be switched out of circuit and the crystal oscillator coupled direct to the mixer stage.

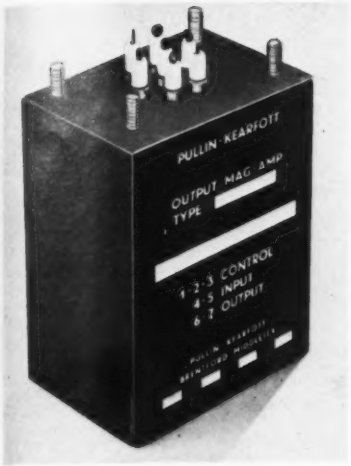
The instrument is basically an f.m. receiver using a counter-type discriminator for high stability; its demodulated output energises a meter calibrated directly in deviation, and is also available externally at a separately buffered outlet for aural monitoring or measurement of very low deviation.

The f.m. input is applied to a frequency changer comprising a tunable local oscillator and a crystal mixer. The resultant i.f. signal is amplified and then converted to a square wave by a limiter circuit. From the square wave, unidirectional pulses are produced by rectification and differentiation. The pulses are integrated to give an output whose amplitude is proportional to deviation and whose frequency is that of the original modulation.

A high order of measurement accuracy



Carrier deviation meter Type TF 719D.



Output magnetic amplifier.

is ensured by the provision of a crystal-controlled deviation standard: when the instrument is switched to Set Deviation, the r.f. and first i.f. stages are disconnected from circuit and the remaining i.f. stages generate a crystal-controlled test signal of constant effective deviation against which the meter scale may be standardised.

Circle 38 *for further details.*

Output Magnetic Amplifiers

THE following range of completely encased output magnetic amplifiers is designed to provide control phase power for the whole range of 400 c/s two phase a.c. servo-motors. The input signal to the amplifier may be provided from a valve or transistor pre-amplifier and for high temperature operation the range is satisfactory to at least +125°C.

There is also a more economical range of amplifiers satisfactory for the ambient temperature range −65°C to +70°C.

Electrical Characteristics

Motor or Motor Generator Type	RH.601 Size 15 R.110-2 R.800	RH.602 Size 18 R.111-2 R.801	RH.603 Size 18 R.112-2 R.806	RH.604 Size 10 RH.118 R.807	RH.604 Size 11 R.119 R.804
Frequency	400 c/s	400 c/s	400 c/s	400 c/s	400 c/s
Primary Voltage	115 V	115 V	115 V	115 V	115 V
Rated Load Impedance (unity power factor) (ohms)	2640	1320	775	250	3800
Power Output (watts max.) (into rated load)	5	10	18	2·7	3·5
Voltage Output (V max.) (into rated load)	115	115	115	26	115
Primary Current (amps.) (at rated output)	·130	·250	·400	0·15	0·12
Quiescent Control Coil Current (each coil) ...	4 mA	4 mA	4 mA	4 mA	3·5 mA
Control Coil Resistance (each coil) (ohms.) ...	3360	4900	5600	3000	3000
Control Coil By-pass Capacitors (μF.) ...	0·1	0·1	0·1	0·1	0·1

Circle 39 *for further details.*

Transistor Test Equipment

THE Winston transistor curve tracer can be used to test individual transistor characteristics quickly. The transistor is plugged in and the various dials give the complete data and the characteristics are displayed as curves on a cathode ray tube. The instrument measures the characteristics of low power transistors. Complete data are obtained for both p-n-p and n-p-n transistor, because the characteristics for the grounded base or grounded emitter condition may be displayed. The voltage ranges provided are far greater than are required by the ratings of present-day transistors.

The current ranges cover transistors in medium power output stages.

The mean power dissipated in the transistor is, usually, only one quarter of the peak high power. Characteristic curves can, therefore, be obtained which would otherwise be impossible with d.c. plotting.

Whenever required, permanent records of the curves may be made by using an oscilloscope camera over the cathode ray tube.

Power Rating:	200, 220, 240, 250 V, 50/60 c/s, 750 watts consumption.
Power Supplies:	+180V, +300 V, −300V, −380 V, and −450 V, +480V, +600 V, −680 V, −860 V, stabilised for variation of ±10 per cent of mains voltages and generated within the instrument. Five generators for the emitter current/voltage, collector current/voltage and base current requirements.
Cathode Ray Tube:	Has own e.h.t. heater supplies and display amplifiers. Type S6G (flat face 6 in. dia., green trace, medium persistence). The face is shielded from unwanted illumination by a hood for easy location of the graticule. Light-tight for oscilloscope camera.
C.R.T. Display:	Full screen deflection may be obtained from 0·6 V d.c. At least one transistor electrode at a time is d.c. coupled to the display system, thus ensuring a correct zero level setting.
Frequency:	1 Kc/s.
Accuracy:	±10 per cent, for c.r.t. display, ±2 per cent, for d.c. measurements.

Circle 40 *for further details.*

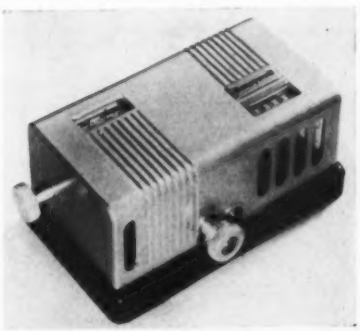
Honeywell Thermostat

A NEW thermostat is being used to solve a ventilating problem for factories and other large areas which use unit heaters and forced air convectors for basic heating. An additional control takes over in hot weather to operate the fans when the heating plant is shut down.

A unit heater installation can now be controlled entirely from the thermostat, enabling the operator to run the equipment automatically as with a conventional thermostat, or continuously regardless of temperature factors. It also allows him to stop the fans completely when the space will be unoccupied for considerable periods.

The new thermostat also provides a useful domestic service for loads up to four kilowatts. The heavy loading allows appliances to be installed which will heat the room much faster initially, without the added expense of installing a double pole switch; and means that control for the installation can be situated conveniently in the room instead of near the mains switch and meter.

The new features of the thermostat are based on a three position manual control with a locking device which prevents it being altered by unauthorised persons or children. The three positions are: *automatic*, which brings the conventional function of the thermostat into operation; *on*, which allows the fans of unit heaters to turn even when the thermostat is not calling for heat, and the *off* position which shuts the plant down completely. This new thermostat and a purely automatic thermostat also with a loading of 4 kW are available with or without a built-in thermometer. Both the thermostats are intended for use with low voltage or line equipment, such as radiators, unit heaters, immersion heaters,



Honeywell thermostat.

cooling equipment, solenoid valves, contactors and starters.

Circle 41 *for further details.*

Mervyn-Harwell Square Wave Polarograph Mark III

In its new form, the Mervyn-Harwell square wave polarograph Mark III is designed for ultimate convenience in use. The instrument is built into a console at which the operator sits. On his right is the built-in recorder on which the polarographic peaks are indicated on a 10 in. wide chart. The main control panel comes easily to his left hand, the various controls being laid out in two groups. Those on the left hand side are concerned with the long term adjustments which need not normally be touched and could in fact be covered if the instrument is to be used by an unskilled operator.

Those on the right of the control panel are laid out in logical sequence and are concerned with the immediate operation of the instrument. In front of the operator is a subsidiary panel containing the pressure gauges associated with the nitrogen supply and a small oscilloscope which monitors the square wave form. Also on this panel is a voltmeter from which the voltage on the cell can be immediately ascertained. The remaining portion of the centre compartment houses the thermostatically controlled constant temperature bath. This contains four cells of an improved design, together with a novel electrode system incorporating a special mercury pressurisation unit to facilitate, by remote control, the maintenance of uniform drop time throughout the potential scan range, and to simplify drop time adjustment. Twin dropping mercury electrodes are provided to ensure that, in the event of an electrode blockage, the process of analysis is not interrupted. The cells are based on the Barker design in which the mercury drops fall into a reservoir beneath the cell. Both the area and the depth of the mercury pool anode are unchanged during tests, and the distance between the pool and the dropping mercury electrode is constant and reproducible. By removing from the electrolysis zone the drops of mercury or amalgam formed during electrolysis, a number of important advantages are derived. The surface of the mercury pool is not physically disturbed, neither is it chemically contaminated by metallic or non-metallic constituents carried down by the mercury drop. Electrode disturbances are eliminated and the volume of the pool is unchanged. Furthermore, the anodic potential of the mercury pool is less susceptible to variations during polarographic tests.

Additional facilities have also been provided for carrying out anodic polarography. The available potential scan has been considerably extended and anodic potentials can now be directly recorded on the chart during polarographic analysis.

The new polarograph represents a complete departure from traditional designs.

It is entirely electronically operated and every device that the polarographer can require is or can be incorporated in the one unit.

It is at least 200 times as sensitive as conventional instruments and it will effectively detect and measure trace elements in the presence of major constituents even at ratios of 20,000 to 1.

Circle 42 *for further details.*

"Batch-counting" bread roll packer.

New Electronic "Batch-Counting" Bread Roll Packer

Efforts to maintain and, if possible, to increase the hygienic conditions under which food is handled during the manufacturing and subsequent "packaging" processes are causing the plant and machinery manufacturers to look towards electronics which can be economically applied to the particular processes in which their machinery or plant plays a part.

Electronic Machine Co. Ltd. have developed a machine which combines their standard batch-counter with a simple set of contra moving canvas belt conveyors.

Bread rolls, which can be fed by hand or automatically on to the conveyor belts, are marshalled into the two outlet ports and pass between the photo-cell and light heads of a standard "B.C.2." batch-counter. This action causes the light beam to be broken and thus a "count" is recorded, the roll then passes down one of the twin outlet chutes and into the waiting carton. The "Batch-counter" is so arranged that by setting of the particular dials each chute can be made to deliver into its carton any combination of rolls, from one dozen to one gross, alterations of numbers being changed by re-setting the dial. The required number of rolls having passed into the carton, the "Batch-counter" then automatically causes a diverting plate to swing across the chute and the rolls now fall into a second carton, thus allowing ample time for the first to be removed for closing and another one put in its place.

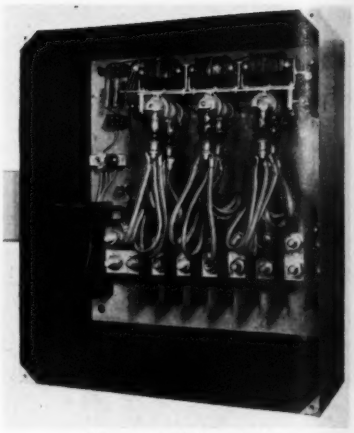
The whole equipment is mounted on easy running castors and is streamlined to eliminate as many dust traps as possible, whilst at the same time facilitating cleaning.

Although designed in the first place for the handling of bread rolls, the unit can be easily adapted and supplied for the handling of many other types of product which lend themselves to the same form of movement as bread rolls.

Circle 43 *for further details.*

Mercury Switch Contactors

A 200 amp, 240 volt, 50 cycle, 3 pole and neutral mercury switch contactor, intended primarily for the control of electric heating, is now in production.



Mercury switch contactor.

Coils are vacuum-impregnated and the use of silicone insulation renders the contactor immune from troubles due to temperature. The magnet system ensures quiet operation without shock.

The bearings are of a special type which never need lubrication and the electrical and mechanical life exceeds 5,000,000 operations.

Circle 44 *for further details.*

Teddington Warm Air Watcher

The Teddington warm air watcher is a control unit in which the fan and limit switches are combined.

The unit is now available with alternative stem lengths to suit different designs of heater casing. Operated by a rugged bi-metal helix, the switch operates independently of the normal burner controls.

The fan switch prevents the discharge of cold air during the starting period and ensures that the residual heat of the exchanger is safely distributed after the burner has shut down. The independent safety switch shuts the burner down if, due to faulty operation, the heat exchanger causes air to be discharged at a dangerously high temperature. Both settings are adjustable. In the standard model the limit switch is latched out after operation to ensure that the cause of failure is recognised and rectified before any attempt is made to start the burner, and the fan switch is provided with an overriding device to enable the fan to be run independently of the burner when required for air circulation during summer weather.

Circle 45 *for further details.*

Single-phase A.C. Watt-Hour Meter Incorporating Two-rate Registers

The increased emphasis being placed by area boards on filling the off-peak periods of the load curve, by the introduction of tariffs to encourage consumers to increase consumption at these times to a maximum, has led to the production by Ferranti Limited of a modern single-phase a.c. watt-hour meter incorporating two-rate registers.

Watt-hour meter.

The meter is a development of the company's FM meter and its design includes the use of roller dials, to meet the increasing demand for this type of counter, and the extension of light alloy techniques to its construction.

A changeover device is incorporated in the meter by means of which the required registering train is brought into gear with the meter spindle. This arrangement can be controlled either by an internal timing device or external time switch. In the latter case, a solenoid operates an armature which changes the gearing between the meter element and the differential.

The accuracy of the meter is unaffected whether it is registering on the normal or the low rate. Accuracy is within B.S.S. limits over a range of 60:1.

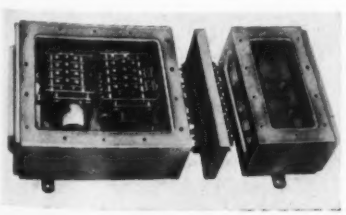
Weight of the meter is approximately 6 lb 5 oz and overall dimensions are: height 9·15 in , width 5·75 in., projection 5·25 in.

Circle 46 *for further details.*

Flameproof Electrical Timing and Control Equipment

THE whole range of automatic, continuously cycling cam operated and hand set process timers, multiple contact and mercury relays, manufactured by Electrical Remote Control Co. Ltd., is now available in Buxton certified Groups II and III flameproof enclosures.

Special purpose control equipment, consisting of a number of timers or relays interconnected to meet the specific requirements of the individual customer



Timer in flameproof enclosure.

are also available in flameproof enclosures. The flameproof enclosures can be supplied with a flameproof push-button, indicator lights, inspection windows, etc.

Circle 47 *for further details.*

P.V. System Test Set

THIS tester is a portable item of test equipment for checking both pressure and vacuum systems at positive and negative pressures within the range of 1 p.s.i. absolute to 115 p.s.i. absolute, i.e., negative pressures 0—30 in. Hg and positive pressures 0—100 p.s.i.

A feature of the tester is that the gauges in the test may be checked without removal from the case, against a standard such as a manometer, gauge or other means of reference. The tester is connected to a standard reference and the pump operated to the required pressure. A comparison is then made between the reference and the test set gauge.

The tester is rapid and easy to operate and is a compact and robust item of test equipment. It is described fully in catalogue No. 1858.

The equipment contains a hand pump, which supplies positive and reduced pressures. The pump is self sealing by means of non-return valves contained in each pressure connection. The pressure line connects the positive pressure side of the pump to a gauge and two capped connections and is provided with an atmosphere vent valve. The negative pressure line connects the negative pressure side of the pump to a gauge and two capped connections, and is provided with an atmosphere vent valve.

Each gauge is fitted with a choke to prevent sudden surges of pressure to the test set instruments.

The standard model is fitted with a pressure gauge 0—100 p.s.i. Two other ranges of gauges are available as required: 0—25 p.s.i. and 0—50 p.s.i. Other types of gauges within a range of 0—100 p.s.i., or equivalent, can be supplied as required.

The negative pressure gauge is ranged 0—30 in. Hg and is standard for all test sets.

Two control valves are mounted on the top front of the test set and are used for venting the positive and negative pressures to atmosphere.

The pump is a piston operated type, complete with non-return valves designed to enable positive and negative pressures in the order of 1 p.s.i. absolute to 115 p.s.i. absolute to be obtained. The design is such that the negative pressure side is automatically sealed when operated on pressure and vice versa. It is recommended that the pump is operated in a smooth and regular motion to obtain the most satisfactory results.

Four capped connections are mounted on the rear of the case; two $\frac{5}{16}$ in. hose for the pressure line and two $\frac{5}{16}$ in. hose for the reduced pressure line.

The test set is mounted on a metal base with rubber feet and is contained in an attractively styled case complete with a leather carrying handle.

Dimensions:	16 in. deep × 7 in. wide × 4½ in. high.
Weight:	8 lb (approximately).
Finish:	Grey stoved enamel.

Circle 48 *for further details.*

*C.U.*100 *pumping unit.*

C.U. 100 Pumping Unit

N.G.N. ELECTRICAL LIMITED have recently introduced the CU.100 pumping unit to their range of pumping equipment.

This unit, designed originally for the Atomic Energy Research Establishment, is a general purpose, high vacuum pumping unit giving access, with a minimum of delay, when required, to the high vacuum chamber. The operation is by means of a single-lever control, working in a clockwise direction to obtain rough pump, fine pump, isolation and air admittance.

The diffusion pump has a pumping speed of 100 litres per second and can attain a pressure in excess of 5×10^{-6} mm of mercury, and can be backed by a rotary pump of 3, 6 or 12 cu. ft. per minute.

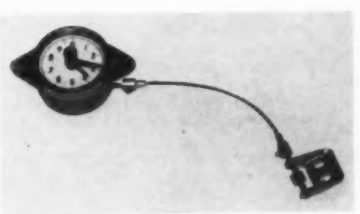
Electrical failure is safeguarded by means of a protective unit which operates solenoid and air admittance valves. Also a water relay is fitted to protect the diffusion pump if the water supply fails. The unit will restart automatically.

Provision is made for fitting a liquid air trap and Pirani direct reading control if required.

Circle 49 *for further details.*

Clock Type Counter Box with Outer Drive Unit

A NEW clock type counter box with outer drive unit, comprising worm, wheel, and flexible shaft, has been specially designed as a revolution counter for use with tape recorders. It may also be used as a footage measuring device for use with film.



Counter box with outer drive unit

Within the Mazac box is a 10-1 worm reduction linked with the input shaft, whose revolutions are recorded by two pointers of 10-1 ratio against a dial calibrated in units and tens up to one hundred.

The outer drive is also a 10-1 pick-up off the initial power supply; a combination which affords a reading up to 1,000 revs of the drive motor. It is reversible and zero setting.

Dimensions: O.D. 1½ in. Depth 1 in.

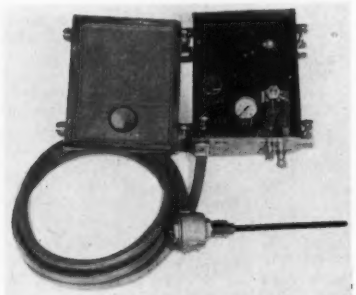
Circle **50** *for further details.*

Transistorised Electronic/Pneumatic Level Controller

THE "Pneutronic" on/off level controller manufactured by Fielden Electronics Limited provides an output air pressure suitable for operating a standard pneumatic diaphragm control valve. The instrument can be used for controlling the level of solids or liquids which may be at high temperatures, high pressures or under corrosive conditions. A robust electrode is the only item in the container and there are no floats, pivots, gears, diaphragms, etc., to become clogged or worn.

The equipment is fully transistorised and operates from a supply of 12 volts d.c.

Circle **51** *for further details.*



Pneutronic on/off level controller with associated electrode.

Semi-balanced Solenoid Operated Valves

THE Series 319 is a range of heavy duty solenoid operated globe pattern valves of the semi-balanced type designed specifically for the control of fluids, including gases in industrial processes.

The standard range of valves is made in sizes from ½ in. to 4 in. bore, suitable for pressures ranging from vacuum to 200 p.s.i.g. maximum.

Special valves are also available for operation at higher working pressures up to 2,000 lb/in² or elevated temperatures, including superheated steam.

All valves can be fitted with supplementary manual operation means and/or interlock switches.

Application

For the control of low, medium and high pressure hot or cold water, steam, most gases including compressed air and CO_2, liquids and refrigerants, etc.

For temperature control in conjunction with temperature measuring devices.

For control of oil and gaseous fuels to boilers and heating plants, etc.

For safety cut-out service.

Circle **52** *for further details.*

New Aerosol Pack for Molybdenised Lubricants

ROCOL LIMITED have introduced a new product, Anti-Scuffing Spray, in an aerosol pack. This pack is the result of a large demand for a quick, handy, efficient method of applying molybdenum disulphide lubricant films to metal surfaces in many industries.

The spray contains a basis of molybdenum disulphide of particle size best for surface treatments, and bonding resin to effect retention of a film, plus a propellant. The vapour is non-toxic, non-corrosive and not harmful or offensive to human beings. The spray is used for the production of a hard bonded lubricating film of molybdenum disulphide on metal or plastic surfaces.

Circle **53** *for further details.*

Tensile Stress Gauge

A DUTCH company has manufactured an apparatus for measuring tensile stress by means of tensile strain gauges. The apparatus is operated by transistors fed by a small built-in nickel-cadmium 6 volt storage battery which can be charged by the electric light mains via a built-in rectifier. As the voltages and currents are exceedingly low, the apparatus is absolutely explosion-proof and suitable for measuring tensile stresses and tensions in coal mines and other spaces exposed to explosion hazards.

The meter comprises a very small oscillator which feeds an a.c. of 1,000 cycles per second to the Wheatstone bridge consisting of tensile strain gauges, an amplifier with a demodulator, and an indicator. The tensile stress of the tensile strain gauges and the resultant diagonal voltages are not measured direct but compared to a second voltage. This compensating voltage is taken from a built-in, manually operated slide wire which also forms part of a bridge circuit. The slide wire is provided with a calibrated graduation.

The measuring range is calibrated from 0—2,000 micro-tensile stress and can be extended to a maximum total range of 30,000 micro-tensile stresses. Even one micro-tensile stress can be detected as a result of the high sensitivity. The accuracy of the apparatus is ±1%, i.e., about 5 micro-tensile stresses. The apparatus is housed in a small metal cabinet with handle and cover. The dimensions are 25 × 22 × 14 cm (9·8 × 8·7 × 5·5 in.) The total weight is 5·6 kg (12 lb).

Circle **54** *for further details.*

Lightweight Transformers

BY taking advantage of recent developments in resin casting, the G.E.C. has developed a range of lightweight high voltage transformers and chokes, suitable for use in airborne electronic equipment. The saving in size and weight of a 23 kV pulse transformer for operation at 70°C can be seen by comparison with a conventional oil-filled version (right) of equivalent performance. In this case a weight reduction of better than 4 to 1 has been achieved.

Circle **55** *for further details.*

E.R.I.C. electronic multimeter.

E.R.I.C. Electronic Multimeter

VOLTAGE, current, resistance and other measurements which would normally be possible only with electrometer or vibrating capacitor circuits are made possible by a symmetrical three-terminal circuit using conventional valves in the E.R.I.C. electronic multimeter. The circuit presents an input impedance of either $10^{14}\,\Omega$ or zero as required. The output impedance of the circuit is virtually zero and feeds an amplifier and meter with the facility for connecting an external recorder.

The circuit design is such that a good degree of stability is achieved and when a voltage is applied in the "memory" position (a polystyrene capacitor is switched across the input circuit) the instrument retains the reading for at least twelve hours, after disconnecting the source, with less than 1% drift.

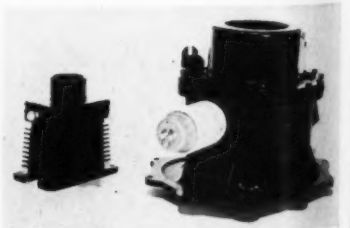
Small voltage variations can be made with full-scale discrimination, regardless of absolute value, using an external capacitor with guard-ring. The capacitor is connected in series with the source and is first charged to the source voltage by short-circuiting the input to the instrument. When the short-circuit is removed, the voltage across the instrument is initially zero and records only variations of the source voltage. By using a constant voltage source, the hysteresis losses of capacitors can be measured similarly.

The basic ranges of the instrument are: 0·05 V to 2 kV, $0{\cdot}5 \times 10^{-7}$ to 2×10^{-3} A, 1 to $2 \times 10^{10}\,\Omega$. A range of adaptors extends the range to 35 kV, $0{\cdot}5 \times 10^{-10}$ A, $10^{13}\,\Omega$. Other accessories include v.h.f. probe, analogue integration adaptor, coulomb-meter adaptor, pH meter attachment. The price is £239.

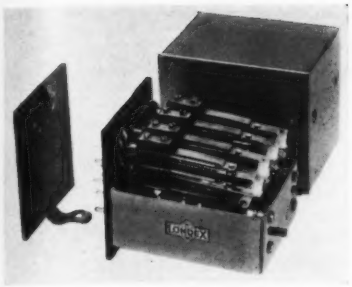
Circle **56** *for further details.*

Type LF Relay

THE Londex type LF relay is now available in plug-in form. The relay in this form provides a unit which can be changed with the minimum of disturbance



Lightweight transformer.



Type LF relay.

and makes maintenance easy, particularly on assembly line control circuits where it is often used.

An 18-way plug and socket is used which allows for a wide variety of contacts to be accommodated. Maximum is eight normally open or eight normally closed or any combination, alternatively five change-over contacts can be fitted. The rating of these is 4 amp at 250 V a.c. Operating voltage for the coil can be from 2 to 600 V a.c. or up to 180 V d.c., power required is from 4 to 12 VA depending on the number of contacts.

A retaining clip is fitted to the socket holding the relay firmly in position. Overall dimensions are $2\frac{3}{4}$ in. × $3\frac{1}{2}$ in. × $4\frac{3}{8}$ in.

This new relay should appeal to those responsible for the design and installation of control panels and other electrical systems in a variety of industries.

Circle **57** *for further details.*

HED Resistance Welding Current Meter

THE HED welding current meter is designed to measure short pulses of heavy current, as encountered in resistance welding machines.

There is no upper limit to the value of current that can be measured, but standard instruments have a minimum of 500 amperes and a maximum of 100,000 amperes over six scales. The minimum pulse time is 10 milliseconds, but pulses down to 2 milliseconds can be measured if several welds are repeated.

The instrument can be used with welding machines employing synchronous, non-synchronous and energy storage controls. Where phase shift heat control is incorporated, a correct factor must be used to obtain accurate quantitative evaluation of r.m.s. current, but a reading can be taken directly for checks of consistency.

A standard split and hinged current transformer is normally supplied which will clamp over any bar up to $4\frac{1}{2}$ in. diameter. Fixed ring type transformers can also be supplied for building into individual welding machines and any number can be switched to a meter.

Circle **58** *for further details.*

HED resistance welding current meter.

The Negactor

THE Negactor can be used to eliminate induction motor slip and increase the torque; with a.c./d.c. motors it can give a large increase in speed as load is increased.

The Negactor principle is used in the Able transductor units, giving control over load voltage which is independent of load current.

Circle **59** *for further details.*

Platinax II

JOHNSON, MATTHEY & COMPANY LIMITED announce that they are now producing Platinax II, a cobalt-platinum magnetic alloy.

After heat treatment by a special J.M.C. process, Platinax II has a remanence of about 6,400 gauss, a coercive force of 4,800 oersteds and a BH(max) of $9{\cdot}2 \times 10^6$ gauss-oersteds being obtainable. In the heat treated state the alloy is magnetically isotropic, exhibiting similar magnetic properties in all planes.

The use of Platinax II offers an advantage in that the alloy is comparatively workable before heat treatment and can be machined, rolled and drawn, without difficulty, and so lends itself to the manufacture of magnets of complicated shape or extremely small size.

Circle **60** *for further details.*

Sparkless Switches

A NEW range of resilient sparkless switches is now being produced, specially designed for circumstances where pollution from the atmosphere, fire and explosion risks are present.

The switches, which employ no springs of any kind, consist of a mercury tube mounted on an insulated carrier, held on a spindle bonded in rubber to an anchor ring. To this ring a plate is fitted which determines the function of the switch to provide either a latching effect (when used as lighting switches or other applications, where a positive "on" position is required) or non-latching when used to replace a push-button control for remote operation.

On the latching type, a locking pin engages with a groove to maintain the switch in a closed position. The application of pressure to the knob immediately causes the switch to return to the "off" or "open" position. The locking pin provides the earth contact to the system to comply with the requirements of the electricity authorities.

These switches can be supplied in dust-proof enclosure, heavy duty boxes with shields and engraved plates, and standard assemblies are available for one to four gang units and can be fitted with any combination of one to four sub-assemblies.

The mercury switches are suitable for 8 amp starting current and 1 amp running current on 440 V supplies, and when used on 250 V supplies are rated at a maximum of 15 amp.

The switch units only, in any of the combinations stated, are also available as separate items for customers to embody in their own equipment.

Circle **61** *for further details.*

Sparkless switch.

ERRATA

The Air Trainer's Link flight simulator which was discussed in *Instrument Practice*, December, 1958, page 1308, is an example of the use of d.c. computation and not, as was stated, an example of the use of a.c. techniques.

Mr. R. B. Nicholes is at *White* Electrical Instrument Co. Ltd. (See *Instrument Practice*, February, page 221.)

EYE-FUNDUS CAMERA

"Eye-fundus" cameras, used for taking photographs of the retina of the human eye, have many applications but in general suffer the disadvantage of being too bulky to move about easily. According to a Japanese report, Dr. Tatsuji Noyori, lecturer on eye diseases at Juntendo University in Tokyo, has succeeded in designing a portable eye-fundus camera which is claimed to be as efficient as the conventional large models now in use.

Circle 52 for further information

Hollerith *plus* Powers-Samas *plus*

equals I·C·T

On 30th January, International Computers and Tabulators Limited (I·C·T for short) became Britain's largest manufacturer and distributor of data-processing machinery.

In this Company, Hollerith has been strengthened by its association with Powers-Samas — and Powers-Samas similarly strengthened by its association with Hollerith. These two Companies established the punched card industry in the United Kingdom and have remained in the forefront of world development in the data-processing field.

What advantages can I·C·T fairly claim? Among others:

The ability to make available a wider range of punched card and computing equipment.

A pooling of the wide variety of experience — 50 years for Hollerith, 43 years for Powers-Samas — in mechanising statistical and accounting procedures and in contributing to scientific management at home and overseas.

The more effective deployment of research and development resources.

On the formation of I·C·T, The British Tabulating Machine Company Limited and Powers-Samas Accounting Machines Limited pay tribute to the very large number of users of their equipment in Government, Local Authority, Industry and Commerce, at home and overseas, with whose support the *Goodwill* of both Companies has been firmly established. I·C·T is proud to take over this *Goodwill*, and assures both present and prospective users that it will be as strenuously guarded as in the past and strengthened in the future.

I·C·T

INTERNATIONAL COMPUTERS AND TABULATORS LTD

REGD. OFFICE: 17 PARK LANE, LONDON, W.1 (HYDE PARK 8155)

All the resources of Hollerith and Powers-Samas

OFFICES THROUGHOUT THE UNITED KINGDOM AND OVERSEAS

NEWS OF THE INDUSTRY

The Institution of Plant Engineers

WITH effect from 16th January, Incorporated Plant Engineers has changed its name to The Institution of Plant Engineers.

Since the Institution is a company limited by guarantee, any change in title needs the sanction of the Board of Trade and where the desired name includes both the words "Institution" and "Engineers", such sanction is by no means automatically given. Furthermore, the Board's requirements are particularly stringent when a body holds (as the Institution does) a licence to dispense with the word "Limited".

Essentially, the Board needs to be satisfied that the grant of the title will not damage the status and standards of the engineering profession as a whole or those of the established professional Institutions.

That permission has been granted is, in these circumstances, a gratifying recognition of the work of the Institution.

Solartron Group Productivity Services

AN expansion from 20 to over 1,000 personnel in seven years, a turnover increase from £18,000 to over £2,000,000 per annum, and the conception, development and manufacture of a wide range of outstanding electronic and electromechanical products have led to the natural requirement of this new department. It forms a specialised training and advisory service composed of organisation and methods engineers to ensure that the fullest use is made of all the resources of the Solartron Group by all who need them when they need them.

The continually expanding progress of the Solartron Electronic Group has been largely due to the adoption of a policy of logically formed self-governing groups with immediate communication, when desired, with the Group board. Every subsidiary company has a Group director on its board.

Only a year or two ago, each person knew in general what the other was doing, and how assistance could be given or received. Now, in one year alone, Solartron have engaged more personnel, from cleaners to senior executives, than the total employed three years ago. Thus, company organisation and inter-company communication become problems requiring a focal point for discussion and co-ordination. Furthermore, the subsequent developments require ever - increasing knowledge of management and administrative processes in existing members of the team.

An Organisation and Methods Department was started some years ago. It is now included in the new department because its contribution to the overall success of Solartron has led logically to this wider concept.

The new department also renders general assistance as required. It has its "commando force" which will help administratively to set up any new sections or departments and generally to get new activities started. It has to plan for the future by forecasting the organisations and people required in 2, 5, and 10 years' time, together with the factory space, equipment and other facilities necessary to meeting the needs of an ever-growing enterprise.

Their activities include co-ordination of production services such as planning and work study and, perhaps most fundamental of all, measures of productivity so that the whole group of companies can be continually supplied with facts that will enable them to see how they compare with each other and with the best comparable enterprises in the world.

Beckman Instruments Ltd. New Scottish Factory

EXCELLENT progress is being made at Glenrothes by Beckman Instruments Limited, whose new factory is tooling up for production of Helipots. The Glenrothes factory is one of the most modern in the country and has been designed to provide ideal conditions for the manufacture of precision instruments for the industrial control field. Mr. J. R. MacNally, who is in charge of the development, has returned from a seven-week tour of the Continent and has indicated that prospects for the British products are sound. The Glenrothes factory will manufacture from British materials and with British labour a range of instruments and controls, on the basis of American experience, for use in Great Britain and throughout the world, with the exception of the U.S.A. During his tour Mr. MacNally visited Switzerland, Germany, Italy, France, Denmark, Norway, Sweden, Holland, Finland and Belgium.

These markets will all be supplied and serviced from Glenrothes. Other markets are being developed in South Africa, Australia and New Zealand while inquiries have been received from Japan and India for atomic research instruments.

This tour will be followed by a visit to California for discussions regarding the expansion of the range of products to be produced at Glenrothes. Two new products now being produced in the Scottish factory are a precision turns counting dial and a portable oxygen analyser. It is also likely that production will begin soon on a four layer diode invented by Dr. Shockley, winner of the Nobel Prize and prominent in the development of the transistor.

The present labour force is still small, but is being built up steadily as workers are trained in the high precision methods necessary for this work. This new plant is part of the overall Scottish development of scientific instrumentation production which has added a valuable group of new firms to the Scottish industrial sphere.

Elliott-Automation Subsidiary

ELLIOTT-AUTOMATION LIMITED announces that Elliott Nucleonics Limited is to assume responsibility for the whole of the activities in the nuclear field of Elliott Brothers (London) Limited, Lewisham.

Mr. G. C. Fairbanks, joint general manager of Elliott-Automation Limited, and a director of Elliott Brothers (London) Limited, Lewisham, and Mr. M. V. Needham, have been appointed directors of the company.

Elliott Nucleonics' interests initially will be those developed by Elliott Brothers (London) Limited, which centre around the control and instrumentation of nuclear reactors and power stations, and the associated chemical plants, and the uses of radioactive isotopes in industrial processes.

The products of the company will include the complete range of Elliott nuclear health instruments, of which the beta gamma ground contamination monitoring recorder has been supplied in quantity to Harwell, and the recorders and data processing equipment for burst fuel element detection and reactor temperature monitoring, which are used in the nuclear power stations.

It is intended that Elliott Nucleonics shall carry out the extensive instrumentation and control work being done by the group for the four nuclear power stations currently being built for the C.E.G.B. and the design and manufacture of the control rod mechanisms for the advanced gas-cooled reactor to be built at Windscale.

Changes of Address

CHLORIDE AND ELECTRICAL STORAGE CO. LTD. The news and information service of the Chloride Electrical Storage Co. Ltd., and all the companies within this group, is now being conducted from Whitfield House, 6-10 Whitfield Street, London, W.1. Telephone: MUSeum 1971.

CITY AND GUILDS OF LONDON INSTITUTE. The new address is 76 Portland Place, London, W.1. Telephone: LANgham 3050.

SUNVIC CONTROLS LTD. The commercial, export, and publicity departments and London and Home County Area office are now at Crown House, Aldwych, London, W.C.2. Telephone: TEMple Bar 8040.

Gate Machinery Co. Ltd.

ELGAR MACHINE TOOL CO. LTD. announce that they have formed Gate Machinery Co. Ltd. for the purpose of handling used machine tools. This new company commenced operation on the 1st January under the direction of Mr. J. P. Hatfield, who until recently was manager of the Machine Tool Division of Newman Industries Ltd.

The Yard and the Pound (Avoirdupois) for Science and Technology

"THE directors of the following standards laboratories: Applied Physics Division, National Research Council, Ottawa, Canada; Dominion Physical Laboratory, Lower Hutt, New Zealand; National Bureau of Standards, Washington, United States; National Physical Laboratory, Teddington, United Kingdom; National Physical Research Laboratory, Pretoria, South Africa; and National Standards Laboratory, Sydney, Australia, have discussed the existing differences between the values assigned to the yard and to the pound in different countries. To secure identical values for each of these units in precise measurements for science and technology, it has been agreed to adopt an international yard and an international pound having the following definitions:—

the international yard equals 0·9144 metre;

the international pound equals 0·453,592,37 kilogramme.

It has also been agreed that, unless otherwise required, all non-metric calibrations carried out by the above laboratories for science and technology on and after 1st July, 1959, will be made in terms of the international units as defined above or their multiples or submultiples."

The above announcement is being made concurrently by all the laboratories listed above.

The new international units conform with the recommendations of the Board of Trade Departmental Committee on Weights and Measures Legislation (the "Hodgson Committee") but the Board of Trade point out that the units will have no statutory force in the United Kingdom and may not be used for trade purposes in this country. The yard and pound units to be used in trade are the imperial units laid down in the Weights and Measures Act, 1878.

The values of the yard currently in use in the British Commonwealth and the United States of America are as follows when expressed in terms of the metre:—

1 imperial standard yard = 0·914,397,2 metre.

1 Canadian yard = 0·9144 metre.

1 yard as at present used by the National Physical Laboratory for science and technology, based on the 1922 value of the imperial standard yard = 0·914,398,41 metre.

1 United States yard = 0·914,401,83 metre.

As the imperial standard yard is about 5 parts per million (0·0002 in.) less than the United States yard (which is defined in terms of the metre) and is shortening at the rate of over one millionth of an inch per annum, the consequent discrepancies in measurements of length are important in modern precision engineering. To give two examples, it is necessary to know the lengths of the highest grade block gauges accurately to one part per million, and the permissible error on accurate yard scales is 0·0001 in. Though the N.P.L., by using the metre and wavelengths of light and by adopting the 1922 value of the imperial standard yard in relation to the metre, has been able to stabilise its basis of reference for length measurements in terms of the yard and its common submultiples for science and technology, unification of the yard standard for these purposes in the British Commonwealth and the United States can no longer be delayed.

With regard to the pound, the values currently in use when expressed in terms of the kilogramme are:—

1 imperial standard pound = 0·453,592,338 kilogramme.

1 Canadian pound = 0·453,592,43 kilogramme.

1 United States pound = 0·453,592,4277 kilogramme.

There is evidence that the imperial standard pound has diminished by about 7 parts in 10 millions since 1846. It is about 2 parts in 10 millions (0·0014 grain) smaller than the United States and Canadian pounds, which are defined in terms of the very closely safeguarded international prototype kilogramme. Though the discrepancy between the pounds is not at present causing any technical difficulty, the coexistence of independently defined pounds is unsatisfactory in science and technology.

The agreed international values of the yard and the pound fall between the existing United States and British units, and the international yard, which is the same as the Canadian yard, accords exactly with the relationship 1 in. = 25·4 millimetres, which is already extensively used in this country and abroad for approximate conversions. The adoption of the international values of the yard and the pound will be of particular benefit to all those concerned with accurate measurements of length and mass for scientific and technological purposes in the British Commonwealth and the United States.

Thermocouples Halt Traffic in South London

Two of the biggest thermocouple assemblies ever made recently began a difficult journey from South London to Melbourne, where they are to be installed in a new petroleum refinery.

Thermocouples are usually about 2 ft long, but these assemblies, measuring 45 ft, were too large for the holds of the first ship that was to carry them. Assembled in South London, they were loaded on to a Queen Mary type trailer normally used for transporting aircraft fuselages, and driven to the London docks. Traffic was delayed in the narrow streets.

The thermocouples were supplied by Honeywell Controls Ltd. to specifications laid down by the Standard Vacuum Oil Company Limited. Each contains 12 sets of wires of different lengths, so that temperature measurements are made at 12 different points along the length of the assembly. The wires are protected in a ¼ in. thick stainless steel tube, which is

45 *ft. long thermocouple.*

pressure-tested to 1,700 p.s.i. Each of these two thermocouple assemblies is to be inserted in the top of a catalytic reforming column, operating under high pressure. By making large composite thermocouples instead of installing standard thermocouples at appropriate points in the side wall of the vessel, only two instead of twelve pressure-tight welds are necessary. This means less physical strain on the vessel, and should give the reformer a longer working life.

Smiths-Sperry Instrument Plans

SMITHS AIRCRAFT INSTRUMENTS and Kelvin and Hughes, both members of the S. Smith and Sons (England) group, are to collaborate with Sperry Gyroscope Company (Brentford Division) to develop aircraft control and instrument systems.

No financial link-up is involved in the agreement between the parties, nor does the collaboration go beyond specific civil and military aircraft instrument systems at this stage.

Among the first major projects which will be developed as a result of the new arrangement will be a flight control and instrumentation system for the new de Havilland DH-121 jet airliner.

This system may incorporate automatic blind landing equipment, which British European Airways has already indicated that it would like to have on all its new airliners.

It is understood that an instrument and control system for use in the new TSR-2 Canberra-replacement aircraft may also be developed. No contracts for such a system have yet been placed, but the Smiths-Kelvin Hughes-Sperry team may submit designs.

Flight instrument and control systems for other civil and military aircraft are also likely to result from the new arrangement, but as yet there is no plan to extend the scheme to include work in guided weapons and marine projects.

Simmonds Representatives Visit Norway

MR. P. PEHRSON, executive director, export sales, of Simmonds Aerocessories Limited, and Firth Cleveland Instruments Limited, members of the Firth Cleveland Group, visited Norway in January. He was accompanied by Mr. R. Goodburn, export sales manager for Surform Hand Tools.

Ultrasonics Aids Fountain Pen Production

An ultrasonic cleaning plant has recently been installed by the Parker Pen Company in the press shop of their Newhaven factory, where noses and clips for pencils, and clips, clutches, caps and guards for fountain pens are produced.

The manufacturing operations for these parts are many and varied and in almost all cases involve the use of expensive press tools or diamond engraving machines. Owing to the nature of the work, each part may need to be treated by several machines in succession.

The tools and diamonds used for engraving are very susceptible to damage by the presence of dirt, which may contain hard abrasives, and elaborate precautions are essential to minimise this by exhaustive cleaning of each part before it is put in a machine.

Previously, this cleaning was done by hand, a process that was not entirely satisfactory, absorbing as it did quite a proportion of the labour costs. For instance one particular component part, a "Lustraloy" cap for one of the Parker pens, undergoes 20 processes from its entry into the press shop as a blank to its exit as a fully-machined cap, and no fewer than four of these operations are thorough cleansings.

To improve efficiency and to deal with the fact that component parts for pens were becoming more numerous, ultrasonic cleaning equipment was installed to increase the output of the shop and lower the costs. Besides saving in labour and space, the ultrasonic equipment now enables as many parts to be cleaned in one day as was previously possible in a week.

Owing to the effectiveness and uniform nature of the ultrasonic cleaning, the possibility of any tool or diamond damage due to dirt has also been greatly reduced. There is in addition a complete lack of "aftermarking" which occurs with hand cleaning. The drying, which is all part of the overall ultrasonic cleaning process, also saves an operation previously effected by a centrifuge.

The installation consists of a Kerry-Mullard ultrasonic cleaner Type UHD1, driven by a Mullard ultrasonic generator Type L278.

The speed of the ultrasonic cleaner can be gauged from the fact that it handles about 150 caps or 2,000 pencil noses at each filling and the whole cycle—including drying—takes about two minutes. The metals of the parts treated are rolled gold, "Lustraloy", stainless steel and nickel silver.

The actual cleaning takes place in perchlorethylene which is heat controlled and ultrasonically agitated by crystal transducers fed from electronic generators. In a separate compartment in the equipment perchlorethylene vapour at a temperature of approximately 120°C heats the components so that they flash dry as they are brought through cold coils. This section also continuously distills the solvent in the circuit to ensure it is kept clear of soluble contamination. Particle contamination in the ultrasonic tank is dealt with by a pumping and filtration system which forms part of the equipment, thus by efficient filtration and distillation the liquid is maintained at a high degree of cleanliness, which is essential if effective ultrasonic cleaning is to be achieved.

In addition to the above applications for their range of fountain pens and propelling pencils, the Parker Pen Company now have a second Kerry-Mullard ultrasonic cleaning installation undergoing initial tests in connection with the manufacture of ballpoint components.

Emidec Computer for ICI Plastics Division

Imperial Chemical Industries Ltd. has placed an order with E.M.I. Electronics Ltd. for what when completed will be one of the most advanced integrated data processing systems in the country.

The system will employ an FMIDEC 1100 electronic computer which will be installed at Welwyn Garden City to handle a wide variety of clerical work for the company's Plastics Division.

The EMIDEC 1100 was selected after careful evaluation because it was considered the most suitable to handle the complicated stock control, distribution procedure and product costing associated with the fast-expanding Plastics Division. All these data processing operations are inter-related in varying degrees, and the Plastics Division therefore plan to utilise the computer in its most advanced conception—as the nerve-centre of the organisation rather than as an isolated unit handling a specific task.

Some idea of the complexity of the clerical work involved can be gathered from the fact that the division carries some 33,000 stores items, ranging in price from pence to pounds. In addition to the maintenance of stock records and the automatic production of reports and statistics, which provide the means of controlling stores items, the computer will also pass forward for product costing priced data relating to issues and suppliers' invoices.

The computer will carry out detailed product costing by the daily collection of job code numbers. Weekly wages analyses will list job codes to which the wages are to be allocated, and the computer will also prepare remittance sheets and covering lists for all the division's suppliers.

The computer is scheduled to be delivered to Welwyn Garden City in March, 1960.

BICC Cables in the Argosy A.W.650

A contract has been received by BICC from Armstrong Whitworth Aircraft for the cable requirements in the new Argosy A.W.650 freightercoach aircraft.

The first Argosies have been wired with BICC Nyvin and Tersil cable, standard types produced and developed by BICC during the past two years.

The outstanding features of these cables are their resistance to abrasion, fuels and solvents, general reliability and durability coupled with the fact that they are easily handled. Tersil cable can withstand a 1,100°C flame for 5 minutes without breakdown, making it suitable for essential circuits. Nyvin, capable of operation at continuous temperatures up to 90°C, is light and small and suitable for general service.

New Firm: R. F. Fraser-Smith

A new firm, R. F. Fraser-Smith, 69 King's Cross Road, London, W.C.1, has been set up, principally for the manufacture and supply of industrial radiographic equipment and accessories.

A.E.I. Chairman Visits Latin America

On 25th January, Lord Chandos, chairman of A.E.I., left on a visit to Latin America where he will meet Government and business leaders in Brazil, Venezuela, Mexico, Argentina and Chile.

In Buenos Aires, Lord Chandos will see work on the £30m. power station being built there by the British Thomson-Houston / International Combustion Limited Partnership. Metropolitan-Vickers are also supplying equipment for the seven sub-stations related to this contract.

In Brazil he will visit the Metropolitan-Vickers traction motor repair factory at Belo Horizonte.

Plessey Propose U.S.A. Tours for Top Apprentices

Three to six-month prize tours of America for outstanding apprentices of The Plessey Company Limited are envisaged in the near future, it has been announced by Mr. A. E. Underwood, the company's resident director at Swindon. The prize tours would include visits to some of the American companies associated with the Plessey Group.

Mr. Underwood added that the company was also considering launching a commercial apprenticeship scheme which might include girls as well as boys.

Mr. Underwood was speaking at a prize-giving ceremony for apprentices trained in the company's school at Swindon at which awards were presented to the thirty prize-winners by the Mayor of Swindon, Alderman F. J. King.

BICC Gloucester Branch

British Insulated Callender's Cables Limited announce that their Gloucester branch has acquired an additional telephone exchange line, Gloucester 21377. This is additional to the present number which is Gloucester 21376.

"Ease" in London

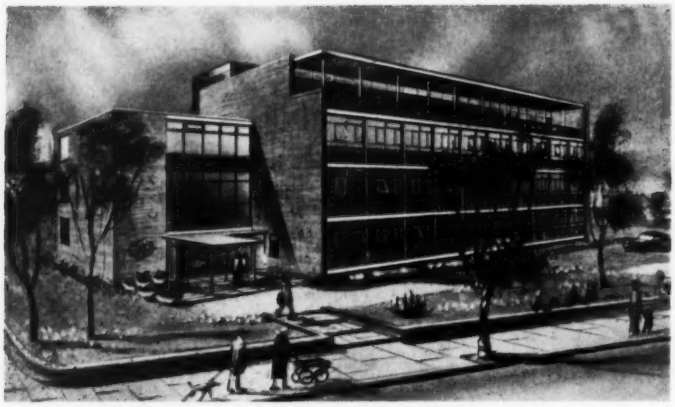
The Beckman/Berkeley EASE, Type 1100, computer, with digital output input translation, was flown to Britain early in February and exhibited privately by the Beckman / Berkeley agents in Great Britain, Winston Electronics Ltd.

Solartron Supports Indian Science Congress Exhibition

Mr. Hugh D. Binyon, instrument sales director of the Solartron Electronic Group Ltd., recently flew out to New Delhi to attend the Indian Science Congress and to be present at the stand of the Solartron Electronic Group at the exhibition held in association with the congress.

Solartron is also in the course of the formation of a company in India together with Indian interests.

Mr. Ambika Prasad, who for some years has handled the Far Eastern export side of Solartron's work, is, together with Mr. Galen Balfe, now at the Solartron office at 17 Queensway, New Delhi.



Artist's impression of new Cambridge Instruments Research Laboratory.

New Instrument Laboratory for Cambridge Instrument Co. Ltd.

CONSTRUCTION has commenced of the new Research Laboratory for the Cambridge Instrument Company. Overlooking the River Cam and Jesus Green, and within ten minutes' walk of the centre of Cambridge, the 20,000 sq. ft. building will provide an imposing frontage for the Cambridge factory.

The top floor with roof lighting will form an ideal design and drawing office, and the three floors below are being fitted with the latest equipment for instrument work involving physics, chemistry, electronics and precision mechanical engineering. The new building heralds a considerable expansion in research, development and design for which staff are currently being recruited.

The architects are Messrs. Edward D. Mills & Partners, designers of the British Industries Pavilion at the Brussels Universal and International Exhibition, 1958, and Messrs. J. Jarvis & Co. the main contractors. The new laboratory is scheduled for completion in June next.

International Convention on Transistors

THE Radio and Telecommunication Section of The Institution of Electrical Engineers have found it necessary to hold their International Convention on Transistors and associated semiconductor devices a few days earlier than previously announced.

The new dates are **21st-27th May, 1959.** The alteration has become necessary through changes in the availability of some of the accommodation at Earl's Court, where the Convention is to be held.

Associated with the Convention will be an International Technical Exhibition covering the manufacturing, application, research, development and other aspects of transistors and associated semiconductor devices. This Exhibition, which will remain open during the period of the Convention, will also be held at Earl's Court.

Those interested in attending the Convention should apply to the Secretary, The Institution of Electrical Engineers, Savoy Place, London, W.C.2 (TEMple Bar 7676). Enquiries about exhibition space should be made to Industrial and Trade Fairs Ltd., Drury House, Russell Street, London, W.C.2 (TEMple Bar 3422), who are arranging the exhibition on behalf of The Institution.

L.L.U. Translations Bulletin

THE Department of Scientific and Industrial Research's Lending Library Unit is introducing a new publication under the title "The L.L.U. Translations Bulletin". It aims to provide British scientists and engineers, who are anxious to have details of current U.S.S.R. research, with up-to-date information on the availability of Russian translations. It will be published monthly.

The Bulletin contains lists of books, journals and other scientific papers which are now available or which are being translated and will become available in the near future. One section deals with cover-to-cover translations, a scheme for providing a complete Russian technical journal in the English language, and another gives details of the work being carried out by the National Science Foundation in the United States, with whom the L.L.U. collaborates in this translation scheme. Many translations from America are held in London on microfilm and photo-copies may be borrowed.

The Bulletin also contains articles on new scientific developments in Russia. These can be followed up in detail with the aid of L.L.U.'s comprehensive collection of Russian scientific literature.

It is contemplated that in the future the Bulletin will cover other language translations.

Cambridge Instrument Showroom

FOR many years Cambridge Instrument Company Ltd. have had the problem of displaying modern industrial and scientific apparatus in a Georgian setting.

Their showroom at 13 Grosvenor Place, London, S.W.1, has now been completely redesigned and redecorated in modern style. Tasteful new furniture has been installed, and, most important of all, the instruments shown are the latest models, mounted on well-designed, easily accessible fixtures and showcases.

Lighting problems were solved with the co-operation of The General Electric Company Ltd. Maple & Co. Ltd. supplied part of the furniture, and H. Benfield Ltd. carried out the decoration.

Visitors, particularly from overseas territories, will be welcome, and will be able to discuss their instrument problems with experienced members of the staff.

Painton & Co. Ltd. and Bourns Laboratories Inc., Agreement

PAINTON & CO. LTD. have recently concluded an agreement with Bourns Laboratories Inc., of Riverside, California, U.S.A., whereby they have the exclusive European and Australian manufacturing and distribution rights for the well-known range of "Trimpot" potentiometers.

Leading Scientist to Open Corrosion Exhibition

PROTECTING hundreds of millions of pounds' worth of Armed Forces' equipment against corrosion damage is a major task of Ministry of Supply scientists. It is appropriate, therefore, that the V.I.P. who will open Britain's 1959 Corrosion Exhibition on Monday, 27th April, is the chief scientist of the Ministry of Supply, Sir Owen Wansbrough-Jones, K.B.E., C.B., Ph.D., F.R.I.C.

Sir Owen, who runs one of the biggest scientific organisations in the country, was trained as a physical chemist at Cambridge under Sir Eric Rideal and at Berlin under Fritz Haber. Soon after the war started he was in the Army, working on chemical warfare, but the scope of his work widened to embrace a variety of scientific and technical matters which he tackled as a general staff officer. He became scientific adviser to the Army Council in 1946. In 1950 he transferred to the Ministry of Supply as director general of scientific research in respect of Army requirements and two years later was promoted to chief scientist.

Among his many outside interests, Sir Owen is treasurer of the Faraday Society, a body which has done much for the study of corrosion, and, at the other end of the scale, he is concerned with practically the only field of metallurgy in which corrosion is no problem—the noble metals; he is a member of the Court of Assistants of the Goldsmiths' Company.

Over 70 firms are showing at the Corrosion Exhibition which will be open for four days, 27th-30th April, at the Royal Horticultural Society's New Hall Westminster. Tickets are available from the organisers, "Corrosion Technology", Leonard Hill House, Eden Street, London, N.W.1.

Mullard Educational Filmstrips

A NEW SERIES of filmstrips dealing with the history and basic principles of important scientific developments has been announced by the Mullard Educational Service.

These filmstrips are aimed primarily at secondary modern pupils, but will also be useful for grounding grammar school arts pupils in some science subjects.

The first strip, entitled "The History of Radio", is available now and brief details are given below. The next, on "The

History of Television", will be released shortly.

The introduction of the secondary modern series brings the number of filmstrips available from the Mullard Educational Service to over 30. These include a series covering the general principles of electronics at grammar school level, and a series for technical college students taking the Ordinary National Certificate in electrical engineering.

"The History of Radio" (35 *frames, colour*)

"The History of Radio" reviews the progress made in telecommunications from the days of the first primitive telegraph and telephone systems. It outlines the discovery of electro-magnetic waves, illustrates Marconi's experimental work, including the historic transatlantic wireless transmission, and ends by describing modern radio communication techniques and showing examples of present-day broadcasting equipment. Wherever it is necessary to the development of the story, fundamental principles of electricity and magnetism are simply and concisely explained.

A comprehensive set of teaching notes is supplied with the strip, which is available from the distributors: Unicorn Head Visual Aids Ltd., 42 Westminster Palace Gardens London, S.W.1. price 20s. 0d. a copy.

"Electrified Production"

"ELECTRIFIED PRODUCTION" is the title of a new quarterly illustrated four-page newsletter prepared by the Electrical Development Association, and intended for distribution by the Electricity Boards to selected industrial consumers in their areas.

The first issue is prefaced by a message from Lord Chandos, immediate past-president of EDA, in which he says:

> "There is no single industrial concern, whether large or small, which has all the 'know-how' of electrification, and there is no other publication in this country devoted solely to industrial electrification. This modest newsletter does not aspire to fill the gap completely but, within its bounds, it hopes at least to suggest new, electrical, solutions to production problems; to indicate the sources of further information. Above all it hopes, by putting forward ideas, to stimulate other ideas and to earn the right to be read even by those whose spare time is small."

The newsletter also contains several brief notes on specific applications of electricity to industry, and an account of the electrification of a Stoke-on-Trent pottery. The author, one of the firm's directors, says that before electrification they were using coal-fired bottle kilns, but electrical methods have undoubtedly been the key to their post-war development and have enabled them to compete with increasing success in export markets, not only in price but in product quality. Furthermore, they have vastly extended the useful life of their factory buildings, parts of which are over 200 years old.

Copies of *Electrified Production* can be obtained either from Electricity Boards, or direct from EDA, 2 Savoy Hill, London, W.C.2.

Avo—Taylor Electrical

Avo, makers of electrical, electronic and nucleonic instruments, has taken over the instrument manufacturing company, Taylor Electrical Instruments, of Slough, by a purchase of the entire share capital of the latter undertaking.

Lord Brabazon to Open Electrical Show

LORD BRABAZON OF TARA will open the Electrical Engineers (A.S.E.E.) Exhibition at Earl's Court on 17th March.

Lord Brabazon is president of The Royal Institution of Great Britain; he is also actively connected with a number of industries, particularly the aircraft and electrical industries. Lord Brabazon is also chairman of the Air Registration Board, chairman of Associated Commercial Vehicles Ltd., a director of Electrical and Musical Industries Ltd., of Kodak Ltd., and David Brown & Sons. He is president of the Radio Industries' Council. He has been both Minister of Transport and Minister of Aircraft Production. A pioneer in aviation, he holds No. 1 certificate granted by the Royal Aero Club for pilots and won the *Daily Mail* £1,000 prize for flying a circular mile on an all-English made machine in 1909. During the first World War he served with the R.F.C., and was responsible for aerial photography and its development. He served as a member of the original Civil Aviation Committee and also of Lord Weir's Advisory Committee. He is a past-president of the Royal Aeronautical Society, and Royal Aero Club.

Amongst equipment of every type worth a total of more than £2,000,000 which will be on show at the 1959 Exhibition will be many items connected with aircraft and photography. Special warning systems for aircraft to guard against wings icing up will be included in the display. The show will occupy more than 450,000 sq. ft. and more than 430 firms will take part in presenting the most up-to-date products of Britain's electrical industry.

Since 1959 is the Golden Jubilee year of the Illuminating Engineering Society, there will be special features devoted to illumination. A unique lighting feature on the ground floor with 4,000 changing lights will demonstrate automatic control and the use of colour. On the first floor a feature in two parts will present the most modern ideas of a new town's shop window lighting as well as a special demonstration of light, colour, sound and animation. The latter will run along the lines of the popular Son et Luminère which was successfully introduced at Greenwich Park but will incorporate more advanced automatic control and it will be the first time that anything on such a large scale has been attempted indoors.

One of the latest diesel electric engines weighing more than 40 tons will be displayed in the forecourt of Earl's Court.

An interesting and unusual exhibit will be a new optic which is due for installation in the Eddystone lighthouse during 1959. This equipment has been constructed to the order of Trinity House, by whose courtesy it will be shown, and it will replace the optic and rotary mechanism which was built and installed by the same firm in 1882 for Sir James Douglass' famous lighthouse. The old optic, 12 ft high by 7 ft diameter, is illuminated by a petroleum vapour burner and transmits a double-flash of about 600,000 candle-power every 30 seconds. The new optic, only 3 ft by 3 ft, employs an electric lamp and lens array to transmit a double-flash of equal power every 10 seconds. The beam range in good visibility is about 17 miles but the loom will be visible beyond the horizon.

Industrial and domestic equipment will be on show and there will be a total of more than 40,000 individual items of equipment.

Education within the industry will again be featured and Government Departments, the Services and Trade Organisations as well as individual firms will combine in one section to show facilities for training offered to newcomers into the industry. For overseas visitors there will be every facility; interpreters, guides and secretarial services.

The exhibition remains open from 17th-21st March.

Texas Lower the Price of Progress

TEXAS INSTRUMENTS LIMITED, of Bedford, recently announced the third substantial price reduction within twelve months.

The prices of almost all Texas transistors and rectifiers have been reduced, some by as much as 35%, thus bringing the well-known advantages of silicon semiconductors within the reach of a larger range of electronic equipment designers. It also helps to reduce the cost of aircraft equipment, control gear, guided weapons, power supply units and other equipment where their use is essential and already established.

These reductions are made possible by improved manufacturing techniques and increased production.

This progressive policy leads to ever-increased demand and therefore still lower prices, and has already resulted in the production area at Bedford being doubled within the past year. It is planned to double this again during the next six months, and it is confidently expected that further price reductions will be announced in the months and years to come.

New Method of Book Production

IF the book you want is out of print, a one-copy edition can now be printed specially to order by a new method of book production.

The Publishers' Association has now approved forms of agreement to be concluded with publishers to cover books that are still in copyright, but, of course, there are many thousands of books which are out of copyright. Old and rare books which are out of copyright can also be reproduced by this method. Microfilms now become not just a convenient way of storing information but an intermediate between the printed original and the printed copy. This is made possible by the technique of xerography (electrostatic printing) which can enlarge from microfilm on to ordinary plain paper.

Pioneering this new method are University Microfilms Ltd., of 67 New Bond Street. Where a book is still in copyright, they will first get the publishers' consent, then will microfilm each page which is to be reprinted. The film is processed and

then put on to a Copyflo automatic xerographic machine. As the Copyflo produces 20 feet of prints a minute, the actual printing operation for a 200-page book takes only five minutes. This xerographic printing is done by the Rank-XeroX Copy Service at 33-41 Mortimer Street, London, W.1.

When "perfect" bound and covered, a 250-page book costs about £5 15s. 0d. (including microfilming) and further copies cost about £4 15s. 0d. each.

About 14,000 new titles a year are published in Britain alone and it is therefore inevitable that many valuable books on all kinds of topics go out of print. Where the further demand is only for a small number of copies it is completely uneconomic to produce them by conventional methods. This new method, therefore, is complementary to conventional printing, and enables publisher and author to satisfy the customer who wants an out-of-print book.

Probably about 10,000 titles go out of print every year.

Libraries, universities, industry and the individual reader will now be able to fill gaps on their shelves and also to replace deteriorating books with xerocopies. In addition, xerocopies can now be made of valuable books, so that the original need never be handled and copies are available for lending, sending overseas, etc. By this method, too, new libraries will be able to establish themselves by obtaining copies of important out-of-print books.

This system is not suitable for reproducing half-tones, but texts, diagrams, graphs, charts and line drawings reproduce well.

A.E.I. "Security of Employment"

A.E.I , Larne, Northern Ireland, announce that following the notices which appeared in the English Press recently, it is stated that it has always been intended that the A.E.I. Security of Employment Scheme should apply to the employees of the Turbine Factory at Larne, Northern Ireland. The scheme will be introduced as soon as local arrangements have been concluded.

Each company within A.E.I. is introducing the scheme and announcing details to their employees independently, timing being dependent in every case on local arrangements.

New Service by the Atomic Energy Authority

AN Information Centre has been opened at the London office of the United Kingdom Atomic Energy Authority. Its purpose is to provide a convenient centre in London where members of the public, commercial firms and other organisations may consult published unclassified material (i.e., with no security restrictions) and seek advice on sources of information on United Kingdom atomic energy matters. A collection of U.K.A.E.A. Unclassified Reports is available for reference. Indexes and abstracts of atomic energy literature are filed and publications about the work of the United Kingdom Atomic Energy Authority are available.

The Centre forms part of the Public Relations Branch of the Authority. The facilities which it offers are complementary to the already well-established information services provided by the Authority at Harwell, Risley and, to a limited extent, Aldermaston, for dealing with scientific and technical enquiries.

Enquiries from the Press will continue to be dealt with by the Authority's Press Office at the same address.

Next to the Centre is a photographic library which holds a collection of some 8,000 photographs covering many aspects of atomic energy. Prints may be purchased out of stock or ordered to suit particular requirements. The library also holds stocks of slides in both colour and black and white which are available on loan.

The information centre and photographic library are open from Mondays to Fridays inclusive between 9-30 a.m. and 5 p.m. The address is:—

United Kingdom
Atomic Energy Authority,
11 Charles II Street,
London, S.W.1.

and the telephone numbers are:—

Information Centre	*Photographic Library*
Whitehall 6262	Whitehall 6262
Extensions	Extensions
174 and 176	368 and 369

Q. & Q. Show Assemblages to Science Masters

QUICKFIT AND QUARTZ LTD., makers of interchangeable laboratory glassware, of Stone (Staffs), were among those exhibiting equipment at University College, London, recently, in connection with the Science Masters' Association annual meeting.

Q. & Q. showed sets of assemblages of particular interest to schools, training colleges and universities. These ranged from semi-micro to macro scale units, designed to show the ease with which complete units may be gradually built up from basic sets of parts.

New Braking Research Instrument Carried on Monte Carlo Rally

THIS year Ferodo scientists used ciné camera techniques for recording instrument readings similar to those used in aircraft test beds and experimental rockets.

Stowed away in the boot of a B.M.C. works team Austin A.105 (a Glasgow starter driven by Bill Sheppard) was a small box measuring 9 in. × 6 in. × 16 in. and weighing 26 lb, which contained electro-mechanical measuring devices, a clock, an automatic ciné camera and a lighting system.

By means of thermocouples fitted in the linings of all four brakes, a record was made of brake temperatures, the number of brake applications and the accumulated duration of brake application along the entire route. Every three minutes the lighting was switched on and the 8 mm ciné camera shot one frame of its 25 ft film to record the reading on the compactly arranged bank of dials. Without any outside attention the apparatus functioned for the entire duration of the rally, with the camera re-winding itself when necessary.

When the film was run through afterwards, a comparison of the clock times with the navigator's log gave a general picture of braking performance at each stage of the rally and under its varying conditions.

The apparatus was designed and built by Ferodo research technicians and is being developed for field testing both on Ferodo test vehicles and on those of outside concerns.

Beckman Process Control Instruments

A SERIES of of demonstrations were given recently during which A. Gallenkamp & Co. Ltd. showed some of the instruments of the industrial process type manufactured by Beckman Instruments Inc.

Of chief interest was the industrial gas chromatograph for monitoring four components in up to 10 streams on plant. In the demonstration commercial propane was analysed, using a double column and hydrogen as the carrier gas.

Also on show were an electrolytic hygrometer for monitoring stream humidity up to 1,000 p.p.m., a dissolved oxygen analyser with a sensitivity of 25 parts per thousand million for boiler water feed, a portable paramagnetic oxygen analyser and a laboratory gas chromatograph.

Following these London demonstrations, the instruments were taken to a number of industrial firms for actual plant trials. The applications for which they were being tried included such streams as wind tunnel air, oil refinery gas flows, and coolant gases for nuclear reactors.

Ferranti 3¼ in. Standby Artificial Horizon for Vickers Vanguard

VICKERS ARMSTRONGS (AIRCRAFT) LTD. have placed a production order with the Aircraft Equipment Department of Ferranti Ltd. for twenty of the company's 3¼ in. standby artificial horizons for use on the Vickers Vanguard.

The instrument will be identical to that which already has universal applications, not only in military aircraft, but also in modern civil aircraft such as the Armstrong Whitworth Argosy, Boeing 707-436 and Comet IV's. It meets British Air Registration Board requirements and is claimed to be the most accurate 3¼ in. artificial horizon yet produced.

Fifth International Instrument Show

PRODUCTS from over 50 factories from 10 countries will be shown at the 5th International Instrument Show, sponsored by B. & K. Laboratories Limited. The exhibition will be held at the International Instrumentation Centre, 4 Tilney Street, Park Lane, from 6th to 10th April. It will be open each day from 10 a.m. to 7 p.m. except on Monday (opening 11-30 a.m.) and Wednesday (closing 9 p.m.).

Several new instruments and components will be shown, particularly from overseas. Emphasis will be on new high-speed analogue and digital instrumentation, new components such as the Varicap and Halltron, developments in e.h.f. power measurement and frequency analysis, new measuring microphones and ultra-precision magnetic tape data recorders.

Applications for tickets should be made to the organisers, either at 4 Tilney Street (GRO 4567) or 57 Union Street, London, S.E.1 (HOP 4567).

Griffin and George (Research and Development) Ltd.

A NEW company, Griffin & George (Research and Development) Ltd., has been formed by the Griffin & George Group to conduct research into, and to undertake the development of, new and improved scientific instruments and apparatus for laboratory use and process control.

The research director is Dr. A. J. P. Martin, F.R.S., well known for his work on partition chromatography, acknowledged by the award in 1952 of the Nobel Prize for chemistry (jointly with Dr. R. Synge).

New laboratories to house the research and development staff will be designed and equipped. A major part of the company's effort will be directed towards a review of modern analytical techniques and the development of the instruments and apparatus for applying them in the laboratory and on the plant.

At the same time, in view of its importance in educating the scientists of the future, work will be conducted on modernising and extending the Group's range of apparatus for use in the science laboratories of schools, technical colleges and universities.

Teleprinter Service

THE Birmingham, Glasgow and Manchester offices of The English Electric Co. Ltd. have been connected to the national Telex service. The office numbers are as follows:—

Birmingham Branch office	No. 33177
Glasgow Branch office	No. 77423
Manchester Branch office	No. 66428

James Gordon & Co. Ltd.

As already announced, the Power Plant Division of Elliott Bros. (London) Ltd. moved early in 1958 to the offices of James Gordon & Co. Ltd., Dalston Gardens, Stanmore. From the 1st January, 1959, this division has now been amalgamated with James Gordon & Co. Ltd. so that Gordon can in future offer schemes for complete instrumentation and control (either pneumatic or electronic), for nuclear and thermal power stations, process steam plants, heating, ventilating and air conditioning plants, etc.

Mr. R. Hussey, who for several years was manager of the Power Plant Division, has taken up the position of sales director of James Gordon & Co. Ltd.

Teddington Trade-in Service for Burner Controls

TEDDINGTON INDUSTRIAL EQUIPMENT LTD., makers of the Spediflam II series, announce a new service exchange scheme for Burner Controls. As from this date, any obsolete Teddington burner watchers, stack switches, viewing heads or room thermostats of any other make irrespective of age or condition will be accepted in exchange for current Teddington equivalents at the special trade-in prices.

This new scheme, which makes a generous allowance for old controls, came into effect on 1st January and arrangements have been made to provide off-the-shelf delivery of all current models in the Spediflam II range.

Solartron to Manufacture Consolidated Pick-ups

THE agreement signed in 1957 between the Consolidated Electrodynamic Corporation, Pasadena, California, U.S.A., and the Solartron Electronic Group Ltd., Thames Ditton, Surrey, England, to manufacture and sell "Datatape" magnetic type recorders for data processing has been extended to include a unique range of pressure pick-ups primarily developed for the aircraft industry. The construction of these pressure pick-ups gives extreme accuracy and are temperature compensated from −350°F to +650°F.

They are designed for the precise measurement of pressure where size is an important factor and pressure changes are too rapid for observation and measurement by conventional devices, and where temperature would cause interference.

BTR Industries Ltd. Acquires Microcell Ltd.

THE Board of BTR Industries Ltd. announces that an agreement has been reached in principle whereby the company acquires the whole of the capital of Microcell Ltd. and of the associated companies, Glass Yarns and Deeside Fabrics Ltd. and Artrite Resins Ltd. Mr. Henry Kremer, chairman and managing director of Microcell Ltd., will continue in that capacity and will join the Board of BTR Industries Ltd.

Microcell Ltd., whose main factories are at Camberley and Blackwater, Surrey, in addition to being engaged on important Government work, operate three main manufacturing divisions, namely Aircraft Engineering, Plastics and Electronics, all of which the Board of BTR Industries Ltd. consider fit into the general development pattern of the BTR Group and afford scope for profitable growth in the future in both the home and overseas markets.

English Electric Valve Co.'s Exhibition

THE English Electric Valve Co. will hold a private exhibition at Kensington Palace Hotel from 17th to 21st March inclusive. The display will include a complete range of design technique in valves for radar, communication, transmitting, broadcasting and instrumentation.

New Plessey Company for Magnet Production

THE Plessey Company Limited announce that an agreement for the interchange of technical information concerning the manufacture of cast permanent magnets of high energy, for use in the electronic and electrical industries, has been concluded with the Arnold Engineering Company, of Illinois.

Plessey has for many years been concerned with the development and production of magnetic materials and the new agreement will ensure that adequate technical progress is maintained in the future.

These magnets, which will be marketed under the registered trade mark of "Magloy", have a variety of applications especially in radar equipment, loudspeakers, electrical meters, magnetos, and electric motors and generators.

The magnets will be manufactured by Preformations Limited, a company formed by Plessey for the development and production of permanent magnets in this country.

Directors of Preformations Limited are A. G. Clark (chairman), A. E. Underwood, and Robert M. Arnold (U.S.A.).

The company is located with other Plessey Group plants on the new Cheney Manor factory estate at Swindon, Wilts., where the build-up of the highly specialised plant needed for magnet production has now reached an advanced stage.

Metrology and Research Exhibition

AN exhibition of Zeiss precision measuring instruments was presented recently. Two experts from the Zeiss headquarters at Oberkochen were present throughout the exhibition.

The exhibits included the Zeiss universal measuring microscope, optical dividing heads and surface finish microscopes.

New Associate Company

SAUNDERS-ROE LIMITED have become increasingly interested in certain specialised fields of nuclear engineering and during the last twelve months close contact has been maintained with Nuclear Enterprises (G.B.) Limited, of Edinburgh.

As a result of this association, the two companies announce the formation of a new jointly owned company, Saro-Nuclear Enterprises Limited, with its head office at 53 Parliament Street, London, S.W.1.

The activities of this company will cover the fields of applied irradiation and the application of isotopes to industrial processes.

Official Opening of BICC Cardiff Branch

THE inauguration of BICC's new premises at Cardiff was initiated by Mr. W. A. Gallon, B.Sc., M.I.E.E., M.Inst.F., chairman of the South Wales Electricity Board.

The branch will carry a comprehensive range of BICC products. These include rubber, M.I., and thermoplastic cables and accessories, Bicalex, paper covered and overhead wires and strips, joint boxes, tapes and compounds and mining type couplers. Enquiries on all facets of BICC work can be channelled through their Cardiff Office where they are geared to deal with electrical problems on the spot.

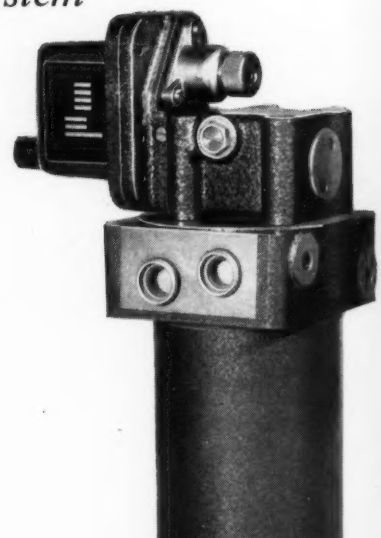
Recent contracts in the South Wales area include the installation of an 18,000 kVAr capacitor bank for British Industrial Solvents Ltd., Kenfig, resulting in an estimated annual saving of £30,000, and very large cable and busbar installations at the Abbey, Trostre and Velindre works of the Steel Company of Wales. BICC's mineral insulated cables in the Empire Pool, Cardiff, which was built for the Empire Games last summer, are featured in the display window of the new offices.

The new branch is under the management of Mr. L. R. Greet, Assoc.I.E.E., Member, A.M.E. & M.E., who has managed the Cardiff branch since January, 1953. Mr. Greet joined the company in 1924 at Cardiff and has been in Cardiff for the whole of that period.

Circle 53 for further information

THREE ESSENTIAL UNITS . . .

. . . for an electro-hydraulic servo system



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1 SERVO VALVE . . .

. . . specially designed for industrial applications. Available for 2·5, 5, 10 and 15 g.p.m. From 4 watt input to 10 h.p. output. Suitable for operation up to 3,000 lb. per sq. in. in temperature range — 20°C. to + 100°C.

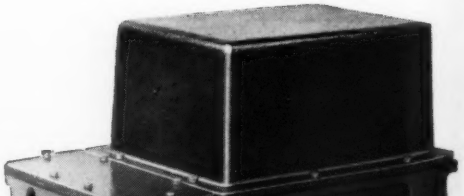
2 MICRON FILTER UNIT . . .

. . . for highly efficient filtration of particles of greater than 5 microns from industrial hydraulic systems. Available for use assembled to the Sperry servo valve or separately as a line filter.

3 SERVO VALVE DRIVE AMPLIFIER . . .

. . . to provide the link between the signalling elements of the servo loop, e.g., Sperry inductive pick-offs, synchros or tachos and the electro-hydraulic servo valve. Transistorised design, suitable for operation on 50 c.p.s. supply. Power gain — 600 mA. differential current into a 20 ohm load with 20mV. input, i.e., greater than 10^8. Designed to comply with *industrial* conditions.

Write, call or telephone for more detailed information.



Servo Valve Drive Amplifier

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ENGINEERING, MARINE, WELDING & NUCLEAR ENERGY EXHIBITION

APRIL 16th TO 30th
STAND No. 9 ROW F GRAND HALL

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EXPORT NEWS

New Freight Link with South East Asia

As a result of an Agency Agreement signed recently between Anglo Overseas Transport Co. Ltd., 29 Mincing Lane, E.C.3 (and provinces) and The Express Transport Organisation of Bangkok, it is now possible for through Bills of Lading to be issued between U.K. and points of entry on the Thai/Laos frontier covering transport via Bangkok, both by sea and air. A covering rates tariff has been introduced for the convenience of shippers.

For some time past Anglo Overseas Transport has been entrusted exclusively with the handling of shipments for Laos financed by the funds of the International Co-operation Administration of Washington, U.S.A., and their services will now become available to all importers and exporters dealing with this territory.

E.M.I.-Cossor Canadian Agreement

THE directors of Electric & Musical Industries Ltd. and of A. C. Cossor Ltd. announce that they have decided on a policy of co-operation in the development of the Canadian market in the field of electronic engineering.

This development will be based on Cossor's existing subsidiary, Cossor (Canada) Ltd., to which further capital will be subscribed by E.M.I. The effect will be to give E.M.I. a controlling interest in the Canadian company, the name of which will be changed to E.M.I.-Cossor Electronics Ltd.

Cossor (Canada) Ltd. has ten years' experience of Canadian market requirements, and an established business in the fields of defence, communications and technical instrumentation, with a factory and laboratories working on radio physics, radar, sonar, radio transmission and reception and allied techniques, using both the results of its own research and development and the technical resources of A. C. Cossor Ltd.

To these will now be added the development and research resources at the disposal of E.M.I., and a considerable range of electronic equipment in such fields as computers (both digital and analogue), data-logging equipment, nucleonic equipment, machine-tool control, broadcasting, character recognition equipment, etc., together with a range of special valves and tubes (klystrons, magnetrons, etc.) of the most advanced types.

The effect of this increase in its financial and technical resources will be to make the Canadian company an important and powerful unit.

The company has a new and modern factory at present under construction, and its staff will be augmented and strengthened as may prove to be necessary in view of the large new commercial programme envisaged.

Mr. Henry Chisholm, joint managing director of A. C. Cossor Ltd., will continue as chairman of the Canadian company. Mr. Clifford Metcalfe, C.B.E., a managing director of E.M.I., and managing director of E.M.I. Electronics Ltd., will become president. Mr. A. C. Carter, as executive vice-president, will continue in charge of operations in Canada. Mr. R. Addie, marketing director of E.M.I. Electronics Ltd., will join the Board, with particular responsibility for commercial development.

Mr. J. C. MacKeen (president, Nova Scotia Light & Power), and Mr. Arthur Levin, M.I.E.E., both of Halifax, and Mr. G. F. Maclaren, Q.C., of Ottawa, will continue to serve on the Board.

The necessary applications have been made to the British Treasury and Exchange Control authorities.

Duty on Scientific Instruments Eased

SIR DAVID ECCLES, President of the Board of Trade, says he is proposing to widen the scope of the arrangements for remitting duty on optical and scientific instruments and apparatus.

The Board of Trade will be prepared to consider applications in respect of all instruments and apparatus imported on or after 1st January, which are covered by the definition in the Import Duties Act, 1958, where the rate of duty is 25 per cent or more and the amount of duty chargeable is £50 or over.

According to Sir David, the imposition of minimum value limit had been necessary in order to make the concession possible without adding disproportionately to Civil Service staffs.

The Board of Trade states that duty may be remitted on the following instruments and apparatus, if similar articles are not for the time being procurable in the United Kingdom:—Optical and scientific instruments and apparatus; measuring and checking instruments and apparatus; apparatus based on the use of X-rays or of the radiations from radioactive substances; thermionic cold-cathode and photo-cathode valves and tubes; discharge lamps.

Marconi Instruments Test Equipment for Malaya

AN order has been received by Marconi Instruments Ltd. from the Telecommunications Administration of Malaya for test equipment to be used in the maintenance of radio telephones employed by the police, fire, ambulance and other services.

Marconi test equipment.

The order comprises thirty of the v.h.f. signal generator, Type TF1064, and the same number of the transmitter and receiver output test set, Type TF1065. In addition, a quantity of the TF995A/4 F.M./A.M. signal generator, a narrow-deviation instrument for v.h.f. mobile equipments, is being supplied.

The TF1064 and TF1065 together provide comprehensive facilities for testing f.m. and a.m. mobile transmitter/receiver equipments; their compactness and portability make them particularly suitable for use in the field. The range of tests which can be made is extremely wide and for receivers includes sensitivity, bandwidth, signal-to-noise ratio, image rejection, discriminator symmetry, and audio power output. For transmitters, P.A. tuning, power output, and deviation can all be checked. General fault finding can be carried out since the test set embodies a multi-range voltmeter/ammeter.

The use of a transistor amplifier is an important design feature of the test set, allowing it to preserve its complete independence from external power supplies. The signal generator is unique in two respects: in addition to providing a.m. facilities, it covers all the f.m. bands used in mobile work and, furthermore, possesses crystal-controlled i.f. outputs.

The picture shows Mr. Lim Hak Sim and Mr. Lau Kam Tuck, engineers of the Telecommunications Administration Department, who are training at the St. Albans factory, discussing some of the test equipments with a Marconi calibration engineer (centre).

Largest Ever (£225,000) Instrument Contract

WE are informed by Integra, Leeds and Northrup Ltd. that their Associates, The Leeds and Northrup Co., of Philadelphia, have received a contract valued at £225,000 from the Argonne National Laboratory for complete instrumentation and control systems for the Experimental Breeder Reactor No. 2 (EBR-2), now under construction at the Atomic Energy Commission's National Reactor Testing Station.

This is certainly the largest contract ever placed for any single reactor facility.

The EBR-2 will be the first civilian

power reactor experiment to operate on recycled fuel. Its primary objective will be to obtain engineering and operational information applicable to full-size central station power plants. It will be an integral power plant and will include a complete fuel processing and fabrication facility in addition to the reactor, heat transfer systems and steam-electric plant.

The fast breeder-type reactor utilises uranium much more effectively than other reactor types because it produces more fissionable material than it burns. It provides the possibility of using economically and efficiently all natural uranium rather than only the uranium-235.

The EBR-2 was developed as a successor to the Experimental Breeder Reactor No. 1 (EBR-1), which became the world's first nuclear power plant to generate electrical power when it was placed in operation in 1951.

The latter demonstrated the feasibility of breeding nuclear fuel in a reactor and showed that liquid metal-cooled systems could be operated reliably and with good stability. However, it only generated 1,400 kilowatts of heat and 200 kilowatts of electricity compared to EBR-2's thermal power rating of 62,500 kilowatts and its gross electrical power output is rated at 20,000 kilowatts.

The whole of the range of instruments involved in the above installation are manufactured by Integra, Leeds and Northrup Ltd. at their Birmingham factory.

Raytheon Corporation U.S.A. and Ferranti Ltd. U.K. in Klystron Agreement

FERRANTI-designed klystrons are to be manufactured under licence in the U.S.A. under an agreement concluded between Raytheon Corporation Ltd., of Boston, Mass., U.S.A., and Ferranti Limited, of Gem Mill, Oldham, Lancs.

A sum of $250,000 is involved in this sale of British "know-how" to the United States of America. The terms of the agreement provide for Raytheon sending a team of engineers to Britain, who arrived recently, to study manufacturing methods and techniques and receive from Ferranti Ltd. manufacturing specifications and drawings.

The agreement involves two tubes; one gives out 15 watts of power as an oscillator and the other is an amplifier giving power up to 2 kW at frequencies in the region of 10,000 Mc/s. They are used in Doppler radar systems.

Ferranti claim that the reason for acceptance of British-designed klystrons by Raytheon was due primarily to the very low noise not yet attained by other valves on the market. The klystrons are intended for use in American military equipment and production in the U.S.A. is expected to commence early in 1960.

Record Sales of British Water Meters to Iran

A NEW ORDER recently placed with George Kent Ltd., Luton, for a further 32,000 water meters—with the option to extend it to 38,400, brings to over £300,000 the value of Kent meters already installed or on order by the Teheran Water Authority since 1956.

The policy of Teheran is to meter every supply of water (to both private and commercial consumers), and as the financial and sociological success of this policy is associated with the accuracy of the meters used, upon which all revenue depends, the merit of this repeat large order is all the more to be appreciated.

Ferranti

FERRANTI has been awarded a new contract by the Tennessee Valley Authority for transformers for the Alcoa switching station in Tennessee worth $486,816 (£173,863).

FORTHCOMING EVENTS

March 10th. **The Society of Instrument Technology.** Cheltenham Section. Rotunda, Cheltenham, at 7-30 p.m. "Instrumentation on the Trans-Antarctic Expedition."

" 10th. **The Society of Instrument Technology.** Manchester Section. "Manchester" Room, Central Library, St. Peter's Square, Manchester, 1, at 6-30 p.m. "Electro-magnetic Flow Meters." L. M. Bennett.

" 11th. **The British Institution of Radio Engineers.** South Wales Section. Cardiff College of Advanced Technology, at 6-30 p.m. "Applications of Photo-electric Cells." F. A. Benson.

" 12th. **The Institution of Electrical Engineers.** Utilisation Section. Savoy Place, London, W.C.2, at 5-30 p.m. "Coal Mining and Electricity." A. F. Foster. "Electric Drives in the Paper Industry." P. D. House. "Standardisation and Simplification of Switchgear." M. J. L. Willison.

" 17th. **The Institution of Electrica Engineers.** Measurement and Control Section, Savoy Place, London, W.C.2, at 5-30 p.m. "Electrical Uses of Atomic Spin." G. Phillips.

" 18th. **The Society of Instrument Technology.** Newcastle Section. King's College, Stephenson B'dings, Newcastle-on-Tyne, at 7-0 p.m. "Operating Experiences on Automatic Control of Large Steam Generators." J. S. Holt.

" 19th. **The Society of Instrument Technology.** East Midland Section. College of Technology and Commerce. The Newarke, Leicester, at 6-30 p.m. Forum on "Accuracy of Instruments".

" 19th. **The British Institution of Radio Engineers.** Scottish Section. 39 Elmsbank Cresent, Glasgow, at 7-0 p.m. "Application of Magnetic Amplifiers to Electrical Switching." J. A. Purdie.

" 19th. **The Society of Instrument Technology.** Tees-side Section. Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, at 7-30 p.m. "Flow Measurement: Some Problems and Devices of Special Interest." W. K. Clark.

" 20th. **The British Institution of Radio Engineers.** Scottish Section. The University, Drummond Street, Edinburgh, at 7-0 p.m. "Application of Magnetic Amplifiers to Switching." J. A. Purdie.

March 25th. **The Society of Instrument Technology.** Chester Section. Grosvenor Museum, Grosvenor St., Chester, at 7-0 p.m. "Industrial Applications of Transistors." D. G. Holloway.

" 25th. **The Society of Instrument Technology.** South Wales Section. Welsh College of Advanced Technology, Cardiff, at 6-45 p.m. "The Instrumentation of a Nuclear Power Station." J. R. Sandiford.

" 25th. **The Institution of Electrical Engineers.** Supply Section. Savoy Place, London, W.C.2, at 5-30 p.m. "The Selection of Insulation Levels and Tests for High-voltage Transformers." G. B. Harper.

April 1st. **The Society of Instrument Technology.** South Yorkshire Section. The University, St. George's Square, Sheffield 1, at 7-0 p.m. "Instrumentation and Automatic Control at I.C.I. Billingham." C. H. Gregory.

" 2nd. **The British Institution of Radio Engineers.** North Western Section. College of Technology, Sackville St., Manchester, 1, at 6-30 p.m. "Principles of Transistor Circuitry." B. R. A. Bettridge.

" 7th. **The British Institution of Radio Engineers.** Computer Group. London School of Hygiene and Tropical Medicine, Keppel St., London, W.C.1, at 6-30 p.m. Symposium on "Large Capacity Storage Systems".

" 7th. **The Institution of Electrical Engineers.** Measurement and Control Section. Savoy Place, London, W.C.2, at 5-30 p.m. "An Electron Trajectory Tracer for Use with the Resistance Network Analogue." M. E. Haine.

" 10th. **The Society of Instrument Technology.** Cheltenham Section. Rotunda, Cheltenham, at 7-30 p.m. "Automation Behind the Iron Curtain." The President.

" 14th. **The Society of Instrument Technology.** Manchester Section. Central Library, St. Peter's Square, Manchester, 1, at 6-30 p.m. "Weighing." T. A. Delve.

" 15th. **The Society of Instrument Technology.** Newcastle Section. King's College, Stephenson Buildings, Newcastle-on-Tyne, at 7-0 p.m. "Radiation Pyrometers." R. Barber.

" 15th. **The Society of Instrument Technology.** Tees-side Section. Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough, at 7-30 p.m. "Instrumentation of Open-hearth Furnaces." C. Holden.

" 16th. **The Society of Instrument Technology.** Control Section. Manson House, Portland Place, London, W.1, at 5-30 p.m. Annual General Meeting. "Self Optimising Control System for a Certain Clan of Randomly Varying Inputs." A. P. Roberts.

April 16th. **The Institution of Electrical Engineers.** Utilisation Section. Savoy Place, London, W.C.2, at 5-30 p.m. "An Electro-magnetic, Variable-ratio, Torque Converter." D. O. Bishop and G. S. Brosan.

" 21st. **The Institution of Electrical Engineers.** Measurement and Control Section. Savoy Place, London, W.C.2, at 5-30 p.m. "The Problem of Maintenance of Electronic Equipment in the Process Industries." Discussion.

" 22nd. **The British Institution of Radio Engineers.** London School of Hygiene and Tropical Medicine, Keppel St., London, W.C.1, at 6-30 p.m. "The Application of Magnetic Resonance to Solid State Electronics." D. J. E. Ingham.

May 1st. **The British Institution of Radio Engineers.** South Midlands Section. North Gloucestershire Technical College, Cheltenham, at 7-0 p.m. "Transistor Amplifiers." F. Butler.

U.S. Science Officer Programme

The Department of State announces the re-establishment of its overseas science officer programme with the appointments of seven distinguished scientists who will serve as science officers in the United States embassies in London, Paris, Rome, Bonn, Stockholm and Tokyo. Although assigned to a specific embassy, the science officer will also provide scientific assistance in U.S. embassies in adjacent areas.

The science officer's primary role will be to serve as an adviser to the ambassador and his staff in the evaluation of the interaction of science with foreign policy, the assessment of current scientific progress abroad and the enhancement of the liaison between United States and foreign scientists and engineers. Physics, chemistry, engineering and zoology are the disciplines represented in the initial appointments.

Dr. Thomas H. Osgood has been appointed science officer for London. Dr. Thomas H. Osgood, a physicist, with a combination of research and administrative experience, has served as the Dean of the School for Advanced Graduate Studies at Michigan State University since 1950. He received his Ph.D. degree from the University of Cambridge, England, in 1927. Dr. Osgood has been active in scientific education, research, and publications. He is currently chairman of the Council of Sponsoring Institutions of the Associated Midwest Universities Programme of the Argonne National Laboratory. He has served as the editor of the *American Journal of Physics* for over 10 years, is chairman of the publications board of the American Institute of Physics, and has been active in the International Union of Pure and Applied Physics.

Because of fulfilling academic and other commitments, all of these scientists will not be leaving for their foreign posts at the same time. Some entered upon their new duties in January while the others will start during the following months.

Smiths Precision Gyro for Polar Routes

In recent years the demand for highly accurate gyroscopes has increased with the development of air routes across the extreme northern latitudes of the world. These gyros must have a forecastable as well as a minimum rate of precession under all flight conditions.

An example of this type of gyroscope is the PDG.1, manufactured by Kelvin Hughes, part of the Smiths Aviation Division, and designed for use in the Smiths Flight System. The PDG.1 is a unit which is interchangeable in the S.F.S. with the azimuth gyro.

These PDG units are in regular service with Canadian Pacific Airlines in Britannias flying the polar route between Amsterdam and Vancouver through Greenland.

In the Arctic regions near the North magnetic pole the magnetic compass is unstable and unreliable, so that heading indications and control are obtained from free, direction gyros. These are gyros not monitored or controlled by the earth's magnetic field as in the gyro-magnetic compass on which modern aircraft generally rely.

The navigation of aircraft in high latitudes depends largely on the accuracy of these gyroscopes known as precision direction gyros (PDG) because they provide the long-term heading information generally presented by a magnetic system. The necessity for gyroscope accuracy and for the forecasting of its precession rate is paramount in polar navigation.

Accuracies required today were not considered a practical possibility a few years ago. Only recently have they been approached by very careful and thorough investigations by the instrument manufacturers into the causes of gyro errors.

This research has revealed sources of error not previously considered and resulted in an electrically-driven gyroscope which is totally enclosed and running at high speeds in a temperature-controlled atmosphere of dry gas such as hydrogen. A far cry from the more familiar air-driven gyro still commonly used in older aircraft today.

A nominal, maximum, random drift rate of less than three degrees an hour, under typical flight conditions, is commonplace with these precision gyros. Under operating conditions, this specification tolerance is achieved and bettered by some considerable margin.

These new direction gyros erect to their case and not, as before, to the horizontal. This means that as the aircraft banks the complete gyro assembly will tend to tilt with the case. In earth erecting gyros, the axis of the gyro-wheel tends to remain horizontal at all times.

The advantage of case erection is that the gyro is not liable to unpredictable drift rates caused by the integration of (a) torque arising from the movement of the 'g' sensitive member such as the globule of mercury in a mercury switch, and (b) the torque applied to the gyro as a result of the 'g' initiated signals from, for example, mercury switches.

Gyroscopes are excellent integrators of forces applied about their axes from different directions, the difficulty being that these forces, caused by the aircraft's movement through the air, are unpredictable in both direction and amplitude. The consequent wander of the gyro caused by them is, in turn, unpredictable.

Case erection does away with 'g' sensing devices and thus removes one of the causes of unpredictable drift.

Compensator Unit

Associated with each precision gyro is a compensator which is scaled to a gyro drift rate in degrees per hour. It enables a combined correction for earth's rotation and gyro drift to be applied in one setting. The compensator is a standard 3¼ in. case instrument fitted with integral lighting of the rate scale.

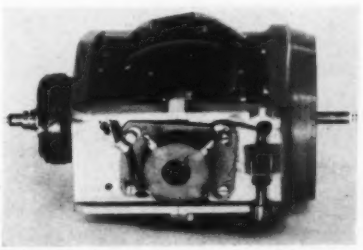
Gyro Compasses

It is sometimes asked why a gyro-compass of the type used in ships cannot by used in aircraft. In this type of compass the gyro is acted upon by a combination of earth's rotation and gravity until its spin axis is aligned to lie parallel with the North-South meridian. A free gyro on the earth's surface would have an apparent tilt as the earth revolved. This tilt is counteracted by a gravity-sensitive device, such as mercury flowing in an arrangement of channels which causes the gyro axis to precess towards the North.

Unfortunately, gyro-compasses are subject to errors which are related to the speed of the vehicle in which they are positioned. The speed of the vehicle tends to alter the apparent tilt of the axis caused by the earth's rotation.

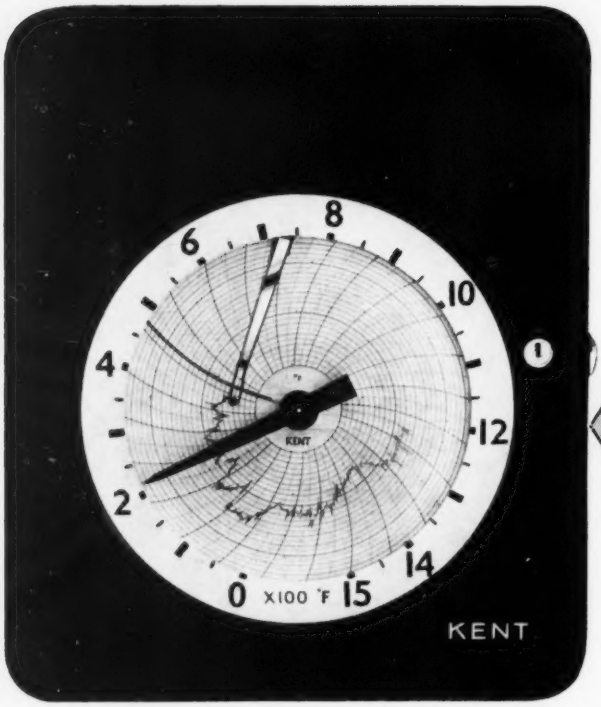
In a ship this is not serious and can be compensated for. But in an aircraft flying at, for example, a speed exactly equal to the speed of the earth's rotation, the gyro compass would, if the aircraft were flying West, in fact lose all its directional property.

The gyro-compass, therefore, depends, for its North-seeking property, on both gravity and the earth's rotation. If one is removed, and the easier of the two to overcome is the effect of the earth's rotation, then the compass will become inaccurate.



Kelvin Hughes precision direction gyroscopes.

Circle 54 for further information



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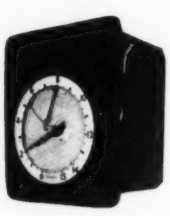

This entirely new high-speed electronic recorder is the latest addition to the KENT *Commander* range of industrial instrumentation, which has already set a new standard in flexibility and ease of maintenance. The *KE* is intrinsically a circular-chart instrument (ring-scale indication, etc. optional) for such process variables as oxygen percentage; glass level; millivoltage; temperature—in association with thermocouple, resistance thermometer or radiation pyrometer; and temperature difference.

What the *KE* does

Records
Indicates
Controls
Transmits
Receives

What the *KE* is

. . . an electronic instrument in the now-familiar *Commander* style of presentation (with attendant advantages of interchangeable-unit construction, etc.), employing fast and continuous balancing by high-sensitivity electronic amplifier and servo motor. Here are some of the *KE*'s features:

- ★ Two speeds of operation—2 seconds or 15 seconds approximately for full-scale travel
- ★ All-mains operation—no batteries
- ★ Entire assembly planned for maximum accessibility; plug-and-socket connections for electronic units
- ★ Choice of amplifiers provides for a wide range of input conditions; amplifier uses standard thermionic valves
- ★ Built-in upscale/downscale drive for external-circuit failure
- ★ Common ancillary units throughout *Commander* instrument range offer very important advantages to users dealing with a host of measurements (rationalized servicing, maintenance and spares stocks, for example)
- ★ Controlling, transmitting and other units in the new *Mark* 30 Series enable even greater stability, etc.

To find out more about the Commander KE, *write for Publication* 352 *and* 993, *or telephone General Industrial Contracts Dept.* (*Luton* 2440, *Ext.* 8) *for a quotation. Literature describing other KENT electronic equipment, such as amplifiers, servo motors, synchronous converters, is available on request.*

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Society of Instrument Technology

Bristol Section

At the first meeting Mr. Coales opened his talk by wishing the new section all success for the future, he thought that the attendance of 45 persons was most encouraging in view of the very heavy rain that evening. The subject of his lecture was his recent visit to Russia, under the title "Automatic Control Behind the Iron Curtain". He described the organisation of the Soviet Academy of Science and gave details of some of the fields of research that they were particularly studying. After an interval, during which refreshments were served, Mr. Coales showed colour photographs that he had taken in Moscow.

For the second meeting Dr. S. M. Makin, of A.E.R.E., Harwell, described the main properties of the radio-isotopes and gave a number of illustrations of the manner in which they can be put to work in solving various problems arising in industrial and scientific work. After the lecture and refreshments a new film on "Radio-isotopes in Industry" was shown.

The lecture by Mr. W. H. McKinlay, B.Sc., A.F.R.Ae.S., on the subject of "Aircraft Flight Instrumentation" was very much appreciated. He outlined the particular problems of an aircraft pilot flying blind and then continued by describing the way in which the vital information was supplied in the early days of flying and how the equivalent modern instruments had developed from these beginnings. The advent of the auto-pilot was described, together with its present limitations and possible future developments.

On 16th December, 1958, Mr. G. P. Tonkin (our vice-chairman) read the paper by himself and Mr. J. B. Bownas on "A Simple Data Read-out System". This is the paper which was read to the Data Processing Section on 20th October, 1958. The prototype device was brought to the lecture and operated.

The one visit that has so far been made was to the C.E.G.B., Bristol Grid Control Centre, which covers the whole of the south-west of the country and South Wales. Members saw the equipment by means of which information is received about all the generators, switchgear, etc., in the area, and likewise the means by which instructions are sent out to the various units of the grid system.

Cheltenham Section

Some 70 members of the local branches of the Society of Instrument Technology and the Royal Aeronautical Society met at the Rotunda on Monday, 3rd November, 1958, to hear a lecture on "Instruments for Guided Flight".

The lecturer was Mr. G. G. Roberts, M.Sc., A.F.R.Ae.S., technical director of Smiths Aircraft Instruments Ltd.

Introducing the lecturer, the chairman, Mr. C. A. Williams, said that Mr. Roberts had a long association with aviation and guided missiles in particular, and that he had recently been awarded, jointly with Mr. Hooper, the Musick Memorial Trophy of the Royal Aeronautical Society for his work on "cloud and collision warning radar".

In his opening remarks the lecturer drew attention to the need for instrument engineers and aeronautical engineers to come together since the future of guided flight depended on their close co-operation.

Mr. Roberts then went on to categorise guided flight as:

(a) The flight of those vehicles in the earth's atmosphere such as manned aircraft and guided missiles.

(b) The flight of those vehicles in the space outside the earth's atmosphere such as Sputniks and Inter-Continental Ballistic Missiles.

The instruments for guided flight were then defined as "sensing elements within the flying vehicle which detect position, motion and changes of motion of the flying vehicle relative to outside space".

Sensing elements were of the inertial types such as gyroscopes and accelerometers and manometric types such as airspeed indicators and altimeters.

Referring to the gyroscope, it was shown that this could be used to define the aircraft altitude and heading but that, due to "wander", it was necessary to provide some kind of monitor. The monitor often used for heading was of the magnetic type, but this suffered when flying the polar routes. Thus the modern gyroscope tended to be an instrument in which absolute accuracy of manufacture, balance and freedom from friction was essential to reduce wander rates and allow it to be used for polar navigation.

Accelerometers were shown to have extreme value for inertial navigation while the simpler instruments such as air-speed indicators and altimeters were essential for guided flight.

The lecturer closed his talk with an invitation to see the many examples of instruments used in guided flight which were exhibited at the lecture.

After a short period for questions the chairman called on Mr. Hancock, technical director of Walker-Crossweller, to propose a vote of thanks to Mr. Roberts. This was enthusiastically endorsed by all present.

Mr. A. E. Bingham, vice-president of the local branch of the Royal Aeronautical Society, also thanked the lecturer for his talk and expressed appreciation of the Society of Instrument Technology for arranging the lecture to which Aeronautical Society members had been invited.

The chairman then closed the meeting and members had an opportunity of inspecting the various exhibits.

Chester Section

The first meeting of the new session was held in the new rendezvous for this season, the Lecture Theatre of the Grosvenor Museum, on Wednesday, 24th September.

Over 50 members were privileged to hear an address by the new president of the Society, J. F. Coales, O.B.E., M.A., F.Inst.P., of Cambridge University, on "Automatic Control behind the Iron Curtain". Mr. Coales is a member of the Executive Council of the International Federation of Automatic Control, and in this capacity he had just visited the Institute of Automation and Telecommunications in Moscow. He spoke of the work which was being carried out there which is mainly concentrated on high-speed pneumatic control systems and ancillary problems. They were proud of their work and were anxious to demonstrate their results.

In the discussion which followed, Mr. Coales said the Russian instrument industry was not so well advanced as their research organisations, and that the bulk of the instruments in use were British and American, they were of course developing their own computers.

The evening concluded with a series of coloured views of Moscow, taken by Mr. Coales.

The chairman was Mr. G. C. Eltenton, vice-president of the Society, and a very hearty vote of thanks was accorded to the speaker on the proposition of Mr. J. W. Till, vice-chairman.

On Wednesday, 29th October, a very enjoyable dinner was held in the Gaumont Restaurant, Chester. About 100 members and friends were welcomed by the chairman, G. C. Eltenton, who extended a special welcome to the acting chairman of the proposed Liverpool Section, Mr. T. Delve. After the chairman's remarks, the party was entertained to a revue by Mr. Ravenscroft and his party from Ellesmere Port. Their efforts were greatly appreciated by the party.

About 40 members attended a very interesting talk by Mr. Offord, general manager, Honeywell Brown Ltd., on Wednesday, 29th October.

His subject, "Problems of Instrument Manufacture", gave him scope to outline the extent of the detailed planning required in both developing a new instrument and extending the production of a standard instrument to meet the needs of a sales department forecast. An interesting discussion followed before a very hearty vote of thanks was proposed by Mr. E. B. Jones.

On 26th November, 1958, Dr. Bradford lectured on "Instrumentation in Chemical Analytical Controls", making the point that quality control during chemical engineering processes has increased to such a degree since the war that it was

usual to have a large number of qualified graduates doing routine analysis checks. It was obvious that the easiest way to meet this misuse of manpower was to develop instrumentation which could look after the simpler routine analyses and so release the manpower to look after the more complicated aspects, as well as research work on new methods and processes.

He then described some of the instruments used for automatic distillation and titration as well as demonstrating fields in which optical and mass spectroscopy and gas chromatography could be used.

A very interesting lecture on "Interplanetary Instrumentation" was given by Mr. B. P. Clear, F.B.I.S., of the Jodrell Bank Research Station, on 10th December, 1958. The lecturer dealt at length with the problem of putting an instrumented space probe into flight or orbit. Assuming that the make up of the rocket was propellant 75%, structure 20% and pay load 5%, the mass ratio would be 4, and even using the highly unstable atomic hydrogen the best mass ratio would be 7.

The main problem after flight would be the power required for transmitting the recorded information back over distances of up to 500m miles. Radio-telemetering offered the only answer as it could transmit signals on either different subcarrier frequencies suitably modulated for coding or a time pulse system: the latter probably being the better as it offered more definite variations. The power would be supplied by solar batteries of the silicon layer type which could be expected to have an efficiency of about 10%. A 7 ft reflecting bowl in an orbit round Mars would generate between 1·2 and 1·7 kW, thus the margin is so small that the more power required for recording instruments, the less power is available for the transmission of these results.

The lecturer then outlined the type of instruments which would be carried by the space probe. In addition to the instruments for temperature, pressure and radiation, they would include a piezo-electric microphone, an erosion gauge to measure the effect of the impact of micro meteorites, Geiger scintillation gauges, and three magnetometers for three dimensional recording.

East Midlands Section

THE section is endeavouring to cover the centres of Nottingham, Leicester, Loughborough and Derby, each with their own industries. Although it may be justifiably argued that a person is more likely to attend a local meeting if the subject is not too closely allied to his own bread and butter, the present policy is to put each subject on its home ground.

The September meeting, being in Nottingham, was therefore on "Instrumentation in the Hosiery Industry", by Mr. D. L. Munden, of the Hosiery and Allied Trades Research Association. Mr. Munden's paper was outstanding for the extremely interesting historical introduction which traced the growth of the industry up to 1900. An illustrated outline of current practice then followed, with the application of instrumentation to various types of plant. Most of these applications are concerned with the control of stitch length and the determination of moisture content in raw material.

The second meeting of the session was held at Leicester where Mr. G. M. Ettinger gave a paper on "Semi-conductors and their Applications". This meeting was well attended by members from English Electric. Mr. Ettinger introduced his subject by reviewing the characteristics of various semi-conductor materials and their suitability from the points of view of both use and manufacture. The speaker then went on to applications of semi-conductor devices, with particular regard to higher powers and frequencies than those popularly supposed to be possible. The discussion which followed dealt mainly with high power applications of transistors.

The November meeting was at Loughborough, the home of the Brush Co., which has done much work on servo-mechanisms at the Jodrell Bank Telescope and elsewhere. Dr. P. J. Bhatt, who has recently been engaged upon research work in non-linear servo systems, introduced the subject of "Non-linearities in Servo Mechanisms" by outlining the differences in the analysis of linear and non-linear systems, and gave brief examples in various methods of solution for non-linear cases. Mr. J. V. Parry, of Nottingham University, then took over and dealt in some detail with the phase plane method of solution. Both speakers are to be congratulated on their "practically non-mathematical" presentation of a subject which is necessarily highly mathematical.

The year's activities were concluded by a visit to the Stanton Ironworks. This visit, as well as having a high general interest value, was very instructive regarding instrumentation in a blast-furnace plant. We are indebted to our hosts at Stanton for giving such a lucid explanation of the working of an extensive plant, and for the welcome they gave us.

Manchester Section

ON Tuesday, 11th November, 1958, Mr. P. H. Mansfield, B.Sc.(Eng.), A.M.I.E.E., British Railways Research Department, Derby, gave a lecture on railway instrumentation.

As the lecture developed it became very apparent that extensive use of the strain gauge was the backbone of the measurement side. Its use in stress problems, in which the railways abound, was well illustrated by slides showing various applications.

The associated instrumentation took the form of electronic multi-channel recording units, which were mounted in a railway coach converted into a mobile laboratory. Further facilities in the form of office accommodation and darkroom were incorporated in this laboratory.

Speed measurement was discussed in which a promising method of photo-electric timing was illustrated.

The evening proved to be very instructive and interesting and was brought to its conclusion in the usual manner. It was followed on Saturday, 15th November, by a visit to the Research Department at Derby when about 16 members were shown round the equipment which formed the subject of the lecture. The efforts of British Railways to improve the comfort of passengers and the efficiency of stock and trade were much more apparent at the end of this visit.

On 9th December the Manchester Section members applied themselves to the problem of instrumenting a process described for them in a flowsheet. The chemical engineering viewpoint was well presented by Mr. S. Kemp. Dr. L. J. R. Postle developed the measurement and process control requirements and Mr. H. Jackman demonstrated the instrument suppliers' approach.

During the general discussion period members first of all showed how the process could be modified with benefit. The control problems were found to be not too difficult provided good measurement could be provided.

The secretary gave his experience with this type of process and brought out an intriguing application of proportional action to the main temperature control; he was heartily congratulated by the meeting on his energy in providing a stimulating problem.

Midland Section

THE Midland Section followed their evening visit to the refinery of Messrs. Midland Tar Distillers with a paper on "Instrumentation in the Oil Industry" by Mr. A. Cowan, of British Petroleum, London, on Friday, 10th October, 1958.

Mr. Cowan opened by giving a history of the development of instrumentation in the oil industry, describing the fundamental requirements of measurement of flow, level, temperature and pressure, and their adjustment to desired values by the operation of valves, this now being accomplished automatically. Automatic control led to centralisation of control, allowed for newer processes with fast reactions and greater accuracies, and the use of remote transmitters, alarm devices and loggers, miniature instruments, graphic panels and "off normal" indicators, all contributed to ease of operation. Direct control from quality of product was developing, rather than the use of regular quality checks to adjust the continuous quantitative control. Instruments were being developed automatically to analyse gas or liquid streams, to do this quickly and continuously and, if possible, automatically to control accordingly.

The speaker then discussed the position today, and suggested that oil refinery control was in a transitional stage between the established "control by inference" method, that is, inferring that certain controlled flow, temperature and pressure conditions produce the required end product, and control by automatic and continuous stream analysis, which method was able to take account of variables such as feed composition, cooling water and ambient temperatures, rate of catalyst reaction, and so on.

The difficulties in developing stream analysers, which are basically industrial variations of sensitive laboratory instruments, and of providing a continuous representative sample, were mentioned. Oxygen analysis and pH measurement and control have been done for some time.

Vapour phase chromatography for multi-component streams has given promising results. The use of such instruments, which generally produce an electrical signal, provided a further argument to the already strong case for the use of electronic control, as also do data handling systems. Developments in the instrumentation of the automatic tank farm and of flow measurement, particularly by positive displacement meters, and turbine type rotor devices were mentioned.

The final section of Mr. Cowan's paper was devoted to a description of the instrumentation of a new refinery and it was interesting to note that this is some 8 to 10% of the capital cost of the process plant. The installed cost of the instruments at the B.P. Refinery (Kent) is approximately £2,000,000.

The paper was accompanied by explanatory slides and a film strip was shown.

On 14th November Mr. S. S. Goldberg, of Imperial Chemical Industries Ltd., Metals Division, gave a paper on "Transistors".

The lecture commenced with a twenty-minute film entitled "The Principles of the Transistor", which gave a simple explanation of the p-n junction diode and the p-n-p "diffused-alloy" type transistor.

Mr. Goldberg stated that, in the ten years since the invention of the point contact transistor, a revolution in solid state physics had taken place, with the development of super-purity germanium and silicon, and the zone refining methods of producing these crystal structures. He dealt with the many uses of the p-n junction diode and the various types of transistors:—the "diffused alloy", the "rate-grown", the "tetrode", and the refined "diffused base" silicon and germanium transistors already capable of oscillation and amplification up to 200 and 1,000 Mc/s respectively.

He briefly explained the double-based diode, or uni-junction transistor, and the n-p-n-p four-layer diode, both of which perform similar functions to thyratron valves, with one thousand times the frequency range of the thyratron.

Mr. Goldberg showed that, with certain exceptions, electronic valve analogies could be used in determining the characteristics and associated circuitry of transistors, which, however, differed from valves in two major respects.

1. They were current, rather than voltage, amplifiers; account must therefore be taken of their circuit resistances.
2. They suffered from a shift in characteristics with ambient temperature changes.

The various methods of obtaining circuit stability and compensation for temperature changes were then considered, followed by a description of the techniques of designing high sensitivity d.c. amplifiers with the aid of chopper and modulator transistor circuits. These amplifiers had the great advantage over their valve counterparts that precautions against hum and noise were less stringent and higher usable amplification was, therefore, easier to achieve. Having briefly dealt with transistor oscillator and pulse circuits, Mr. Goldberg went on to list the great advantages of the transistor in electronic circuitry.

1. High efficiency—the transistor does not require heater power, operating voltages are low and, therefore, transistor circuits are tending to replace complex electronic equipment using valves.
2. Its miniature size and low energy consumption make it possible, together with miniature components, to reduce the bulk of electronic equipment and has introduced a range of low consumption battery units for instrument work.
3. Its theoretically indefinite life (in spite of early failures and the spread of characteristics, due to primitive methods of manufacture) provided new levels of reliability.
4. Its cost should ultimately be substantially below the level of corresponding electronic valves.
5. It has made possible revolutionary new applications and circuit techniques. It has also immensely broadened man's understanding of matter and materials.

On 14th December the Midland Section heard a paper by Mr. Broadhurst, of Imperial Chemical Industries Ltd., General Chemicals Division, Cheshire, on "pH Measurement and Control".

In his introductory remarks the speaker explained that pH is based on the measurement of the concentration of hydrogen ions in an aqueous solution, being originally defined as the logarithm to the base 10 of the reciprocal of the hydrogen ion concentration; 7 for pure water, about 1 for strong acids and about 13 for strong alkalis. An electrode sensitive to the hydrogen ion concentration, and preferably developing a potential in proportion, is inserted into the solution and the electrical circuit completed by a second connection to the solution, normally by means of a calomel half cell. The glass electrode is the most common, and Mr. Broadhurst described and illustrated this, explaining that the internal resistance is very high, 100 to 200 megohms with industrial electrodes, and very sensitive to temperature, so that special methods of measuring the voltage developed are necessary. Measuring circuits in common use included balanced amplifiers, amplifiers having a large amount of negative feedback and circuits which make a ballistic comparison of the voltage across a condenser charged from the electrode system with a voltage derived from a potentiometer. The input impedance should be of the order of 50,000 megohms and the grid current taken by the input valve less than 10^{-11} amp. The requirements of an electrode assembly to give accurate readings and reliable service were enumerated and methods adopted described and illustrated. Capillary leakage of liquor into the electrode housing, with consequent loss of electrical insulation, is a cause of many failures. The effects of temperature on pH measurement were then described and analysed and the manual or automatic compensation circuits dealt with, the latter generally consisting of a resistance thermometer. It was suggested that most laboratory measurements had an accuracy not exceeding plus or minus 0·1 pH, and that plant measurements can have a similar accuracy, but on difficult applications such as effluent systems a figure of plus or minus 1 pH is not uncommon. Plant pH meters should have easily accessible electrode assemblies, for testing, and the accuracy of an installation is best checked with a portable pH meter complete with its own electrodes. In the event of a fault it can be established whether this lies in the electrode system or the measuring circuit by injecting into the latter a millivoltage from a source of constant voltage, when the reason for any electrical leakage or the presence of high grid current can be ascertained. Dealing with pH control, it was explained that the reason why this is much more difficult than temperature or pressure control is that the neutralisation curves for acids and bases are non-linear and exhibit considerable changes in slope. With weak acids and bases, where the curve does not depart greatly from linearity, control is relatively easy but in all other cases can only be achieved under restricted conditions. With batch processes, if the required end point is above 12 or below 2 pH, cut off contacts can be fitted to the pH meter which will cut off the acid or alkali feed at the required point, but if it is between these figures, two different feed rates are a method of achieving control, and very efficient mixing is necessary. Considering continuous processes, an added difficulty is the varying local conditions and to the use of two different feed rates must be added the use of two or more tanks.

Upon the conclusion of the lecture, which had been accompanied by excellent slides, a number of questions were raised and these were ably answered by Mr. Broadhurst.

Scottish Section

On Friday, 19th September, 1958, Mr. A. Stewart, officiating for the first time as chairman, was pleased to welcome members to the opening of the new session. He introduced Mr. Baillie, of the, I.B.M. Co. Ltd., who was the speaker for the evening, his subject being "The Circuitry of a Typical Digital Computer".

Mr. Baillie introduced his subject, stating that the machine he was to describe was not a computer, but a small medium-speed calculator working at a rate of 100 cards per minute, with seventy arithmetical positions.

With the aid of slides, he discussed firstly the five electronic units.

(1) The inverter: a double triode which changes the phase of the incoming square wave signal.
(2) The power unit: this enables the signal to be used to operate a relay or punch mechanism.
(3) The switch unit: controls the impulses to be fed on to other circuits.
(4) The trigger: a double triode is the basic counting unit.
(5) The thyratron unit: which operates the relays and punch clutches.

Mr. Baillie went on to describe the scale of sixteen counters. Having four trigger units, counts of up to sixteen digits could be made. This is rather inconvenient when decade counting is required, so with the addition of a triode connected in circuit, a scale of ten is possible.

Next, the general operation was described, showing how the cards are placed in a feed hopper and pass over the first read roller. The roller is fed with 40 volts through 70 wire brushes, one for each column on the card. The cards pass next to the punching station, then on to a second read roller, which is a checking station, and finally to the stacker. The card reading and card punching systems were described.

To enable the pulses to be identified, a trigger ring operating at 50 kilocycles per second and taking 500 milliseconds to complete a circuit of the ring is used in conjunction with a system of gates. The plugboard was shown, which enables the required programme to be set up.

To do a subtraction, the machine uses the complement of the number. The following problem shows how this is done:—

PROBLEM: 156 − 17 =	139
Counter	000156
Added 17 (in complement)	999982
	000138
Carry from highest position	1
	000139

Mr. Baillie went on to describe methods of multiplication, division and complex calculations such as

$$\frac{(A + B) - C}{D} = E$$

The talk was wound up by a general view of the machine.

On Friday, 28th November, 1958, Mr. J. D. Tallantire, of the I.C.I., returned to the Scottish Section to give his paper, "Analytical Instrumentation of Chemical Processes", in Glasgow.

Mr. Tallantire emphasised that he would be particularly concerned with plant instruments, and not with those for use in the laboratory.

Apart from the usual parameters of temperature, pressure, flow, etc., such quantities as pH, oxygen, viscosity and conductivity need to be measured to give information on the quality of products. The speaker then discussed the reason for the use of analytical instruments. These instruments fall into three groups; chemical, physico-chemical and physical. The first group includes such methods as automatic titration and absorption methods for the determinations of carbon dioxide, the second group includes the Hersch cell for oxygen measurement and chromatographic methods, and the last group includes thermal conductivity, density, viscosity and refractive index; the speaker also mentioned infra-red techniques. Mr. Tallantire then went on to discuss the use of various analytical methods in overcoming the difficult problems of sampling. He concluded by giving some forecasts of future trends in this field of instrumentation.

South Wales Section

THE first meeting of the session of the South Wales Section of the Society of Instrument Technology was held in the Physics Lecture Theatre of the Welsh College of Advanced Technology on 1st October, 1958, Mr. A. D. Thomas in the chair. In his opening remarks Mr. Thomas apologised for the unavoidable absence of Professor R. G. Macmillan who has been elected chairman of the Section following the return of Mr. S. S. Carlisle to London. He referred to the stimulating influence and excellent work of Mr. Carlisle which had been reflected in the progress of the Section during the last two years. It was greatly regretted that his term of office as chairman of the Section had been curtailed and all members wished him every success in his new post.

Introducing the speaker, the chairman said that Mr. Burns, a senior scientific officer at the Battersea Laboratories of the British Iron and Steel Research Association, was indeed well qualified to talk on "Some Applications of Optics in Steel Making Problems" having been largely responsible for the development of these new techniques.

In his introductory remarks, Mr. Burns said that it might seem surprising that optics should play such an important part in steel making research. Sight was, however, the most analytical and highly developed of the human senses; the materials dealt with were often at extremely high temperatures and frequently in extremely rapid motion, both factors giving particular values to optical methods of investigation.

The applications of optics could be divided into three classes according to their purposes, namely, seeing, measurement by seeing and measurement without seeing. There was often a natural development from one classification to the next and in the last class the human eye was replaced by photo-electric devices.

The lecturer then described projects in each category and explained how the peculiar associated circumstances, sometimes beneficial, influenced the method of dealing with problems. He selected the various periscopes as examples of his first class, the most ambitious of these being the furnace scanning periscope designed to inspect or photograph the whole interior of an open hearth furnace from a single position. The optical design was conditioned by the need to enclose the instrument in a water-cooled jacket and to reduce to a minimum the size of the apertures admitting light and unwanted radiant heat. To secure the desired performance the optical head was fitted with a rotating glass plate reflecting a small fraction of the light entering one or other of three small windows which, in conjunction with the rotation of the tube of the instrument, made it possible to examine any part of the furnace interior. Owing to the intense light radiated, optical devices with a high transmission loss could be used, there being still enough transmitted light to make high-speed camera studies at several hundred frames a second. The lecturer then showed a remarkable colour film taken with unimpaired definition from an effective viewpoint inside the furnace walls.

The stereoscopic filming of the combustion zone of a blast-furnace was a research project which provided accurate measurement of an inaccessible fast-moving subject. Conditions in this vital part of the furnace had been the subject of much speculation and attempts had been made to produce a mechanical analogy by means of models. Films were taken through a tuyere using two large silica windows in place of the usual small blue glass and the subject was so strongly luminous that it was possible to achieve the high filming speed of 1,000/3,000 frames per second, necessitated by the rapid movement of the particles. A 16 mm high-speed ciné camera was used in conjunction with specially designed beam-splitters to produce on each frame two photographs of the view seen through left- and right-hand windows. A special optical system was developed to analyse the image of the film projected on a screen in the normal manner. The position of individual particles could be plotted with a high degree of accuracy and their tracks and speeds determined. From this information it had been established that the air blast opened a cavity in the burden two to three feet deep within which the air carried particles flying freely in circulatory motion. Mr. Burns showed a length of stereoscopic film taken through a tuyere of a South Wales blast furnace which was most impressive and indeed remarkable having regard to the difficulties involved.

Briefly reviewing developments in measuring width and sections of hot material, the lecturer described two methods for measuring strip width. For wide and slower-moving strip the position of each edge was measured by two "edge-follower" units, the summation of the two readings producing a width measurement. For narrower and faster-moving rolled strip, a reflected parallel beam passed and was curtailed by the two edges of the strip, thus achieving self-compensation for lateral movement, the width of the residual beam received by the photo-electric unit being an inverse measure of the strip width. This parallel beam technique could be extended to produce images, the size of which depended only on the size and not the distance of an object. This principle was being applied in a number of projects involving the measurement of remote specimens and theoretically it could produce a complete cross-section of an extended object of uniform (but not re-entrant) section by appropriately compounding a large number of side views of the object. This was most convincingly demonstrated by the lecturer when he produced photographs taken by this means together with the original specimens, the cross-sections of which could be seen to correspond exactly with the synthesised profile produced.

Finally, Mr. Burns commented on new developments in light-weight closed-loop television systems and, using an industrial type camera and receiver, demonstrated the versatility of such equipment. It could assist in making exact measurements and, since the output of the television camera is an electrical signal before it is converted back to a visual one, it might in some cases be adapted to replace the human observer.

The meeting closed with a vote of thanks proposed by Mr. R. N. Aldrich-Smith, who paid tribute to the excellence of the demonstration equipment Mr. Burns had prepared for his lecture.

A MEETING was held on the 29th October, 1958, in the Courtybella Institute, Newport, by the courtesy of the Whitehead Iron & Steel Co. Ltd.

Introducing the speaker, the chairman, Professor R. H. Macmillan, welcomed Mr. J. K. Burkitt, the chief instrument engineer for the Alkali Division of I.C.I. Ltd. Mr. Burkitt was a founder member of the Manchester Section and its chairman last session. He had been closely connected with instrumentation, particularly automatic control, from its very early days and could speak with authority on "The Art and Craft of Instrumentation".

In his introduction the lecturer said that, in this connection, art was the utilisation of past experience and craft the scientific approach. A fuller understanding of these techniques would be obtained from an appreciation of the development of the simple instruments of the pre-war era into the present complex control systems; the lecturer supplied the necessary background by showing a series of well-chosen slides. The slides emphasised the history of process controllers from the pre-1930 era when hydraulic instruments based on the "moving jet" gave an excellent performance for pressure, flow and flow ratio applications. In the early 1930's other hydraulic and water operated controllers, depending on a sensitive pilot valve or a moving nozzle for the error measurement, gave a good account of themselves in many applications. However, the real theoretical basis of the modern automatic controller was laid down in 1936 by Callendar, Hartree and Porter in their studies of time-lag in a control system (*Phil. Trans. Roy. Soc.*, Series A, **236** (756), pp. 415–444); this formed the theory for the 3-term controller with its proportional, integral and derivative actions. Slides of some early experimental apparatus were shown, including a very early one where a proportional control operated at intervals corresponding roughly to the time-lag in a process vessel.

Using simple but informative diagrams, Mr. Burkitt explained the principle of the present-day 3-term pneumatic controller and of two recent electronic controllers. He showed that, during the war, the Servo-mechanisms Panel was responsible for a great advance in control theory and that soon after the war the process industries developed their process frequency response techniques. Soon it became evident that gun-laying techniques and process control systems had much in common, the main differences being that of (i) speed of response and (ii) a fixed target (such as a constant temperature or pressure) as against a moving target (such as an aeroplane). The formation of the Control Section saw the amalgamation of the two interests and progress has since been relatively rapid towards a better understanding of control engineering.

At present there are considerable gaps in our knowledge. Progress in the control field is largely dependent on a knowledge of the dynamic characteristics of existing plant so that new plant could be designed in the best possible way by calculating controllability and using instruments to reduce initial capital cost, to give increased efficiency of operation and to release plant operators of stress.

Much operational research had been carried out and the results of factorial experiments could indicate the direction in which the variables should be moved to give the best yield at least cost.

There was little doubt that our present standard of accuracy and reliability would be inadequate for future instrumentation, the necessary improvement involving the development of new techniques.

There was still a future for the pneumatic controller which had in fact reached a very high standard, though electronic control seemed the obvious choice when the initial measuring signal was electrical or when fast response was required. Fewer instruments in the control panel and scanners with alarms and automatic logging replacing continuous recordings would result in far more compact instrumentation. The use of computers, not necessarily complicated digital types, but present analogue computers similar to the Quarrie optimal controller may well be worthwhile.

In all this future work, the research and development engineer will play a very important part in finding new techniques and new instruments to give more controllable and more efficiently designed plants than we have at present. The best results will be obtained by the co-operation of the design, research and development, installation and maintenance engineers, the work being linked intimately with mechanical design and development, plant management and sales requirements. Future developments will therefore depend largely upon combined efforts in operational research and the use of scientific methods rather than the application of a particular science.

Finally, Mr. Burkitt said that there was hope for all of us in exploring the science and art of instrumentation and we could be dignified pioneers without being great inventors.

The meeting closed with a vote of thanks proposed by Mr. J. C. McDonald.

South Yorkshire Section

ON Wednesday, 7th January, 1959, Professor M. W. Thring, of Sheffield University, presented a paper on "Instruments for Flame Radiation and Heat Transfer Measurements". Professor Thring is a recognised authority on this subject but he opened his talk by saying that the work he was to describe had been initiated by many organisations such as B.I.S.R.A., B.C.U.R.A. and the International Flame Radiation Research Group at Imjuiden in Holland.

Many of the required measurements for flame research had now been developed but there were still a few inconvenient omissions. For instance, a measurement of the local emissivity at a particular point in a flame would be most useful but, at the moment, only overall emissivity and temperatures could be measured. The accepted technique at the moment was to use a sighting path through the flame and measure the radiation received from a watercooled background and from a surface of known temperature. Twin thermopile radiation pyrometers simplified the measurement and it was then relatively easy to calculate a flame temperature and emissivity. Care had to be taken in interpreting the physical significance of these results since the distribution across the flame was extremely variable.

Some considerable attention had to be directed at local flame temperature measurements and small suction pyrometers were used with success. The Venturi pneumatic pyrometer developed by B.C.U.R.A. showed great promise of being a reliable instrument for industrial use although some work was still necessary on the design aspect with low Reynolds number. Other long term development techniques such as measuring the velocity of sound or the absorption of α and β rays appeared somewhat clumsy at the moment.

A considerable amount of development work had been carried out on heat flow meters since they represent the best means of measuring flame performance. Conventional types such as the water calorimeter and the thermal conductivity block had been developed for this purpose and various techniques used to attempt to separate the convection and radiation parts of the heat transfer.

Professor Thring finally described a few instruments for such measurements as soot concentration, particle size distribution measurement and velocity distribution, whilst not strictly heat transfer measurements, they were essential to the understanding of the behaviour of a flame.

Some interesting discussion followed his talk, particularly on the subjects of the Venturi pneumatic pyrometer and the design of burners, and finally a vote of thanks was proposed by Mr. T. Land.

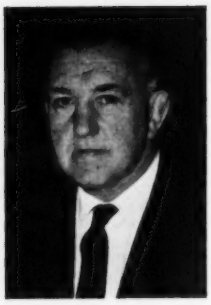
Physical Society Apprentices' Competition

In the Apprentices' Competition for functional scale models of scientific instruments, held in conjunction with the Physical Society, 1959, Exhibition, first, second and third prizes went to apprentices from the North Woolwich works of Standard Telephones and Cables.

Pictured below, with awards after the prize-giving ceremonies, are from left to right: Frederick Young (18), 3rd Prize, Models of an instrument for testing the tearing resistance of cable insulating paper, and of a guillotine for cutting sample test pieces to a predetermined size; Allan Webster (20), 1st Prize, Fly press with blank and piercing tool, and Derick Irving (18), 2nd Prize, Shore scleroscope or hardness tester.

Mr. G. B. G. Potter.

Mr. D. G. Haigh.



Mr. R. Broadbent.

Mr. P. C. Ruggles.

PERSONALITIES

New Appointments at S. Smith & Sons

A co-ordinating board has been appointed to direct and co-ordinate the following units of S. Smith & Sons (England) Limited and its subsidiary companies, which will be collectively known as "Smiths Aviation and Marine Divisions":—

Smiths Aircraft Instruments Limited.
Smiths Industrial Instruments Limited.
Waymouth Gauges & Instruments Limited.
David Harcourt Limited.
Kelvin & Hughes Limited and subsidiary companies.
That part of the business of S. Smith & Sons (England) Limited devoted to the manufacture or sale of aviation and allied products.

The constituent companies of the new divisions will continue to function through their respective boards and executive managements.

The composition of the co-ordinating board is as follows:—

Chairman: Ralph Gordon-Smith (chairman and managing director of S. Smith & Sons (England) Ltd.).

Managing director: G. B. G. Potter, B.Sc., M.I.Mech.E., F.R.Ae.S. (managing director of Kelvin & Hughes Ltd.).

Directors: L. A. Morgan, A.F.R.Ae.S. (director and general manager of Smiths Aircraft Instruments Ltd.); W/Cdr. H. M. Samuelson, R.A.F.O., A.M.I.E.E. (technical sales director of Smiths Aircraft Instruments Ltd.); G. S. Sturrock, M.A. (Cantab.), F.C.I.P.A. (commercial director of Kelvin & Hughes Ltd.).

The administrative headquarters of Smiths Aviation and Marine Divisions will be Kelvin House, Wembley Park Drive, Wembley, Middlesex.

Mr. D. G. Haigh

Mr. D. G. Haigh, M.I.E.E., has been appointed export manager of Chloride Batteries Ltd. He is now responsible for ensuring co-ordination of export marketing within the existing framework of the product selling organisation, for the control of overseas representatives and the overall administration of overseas agencies.

Sperry Reorganisation

The chairman of the board of directors of Sperry Gyroscope Company Limited, Mr. Arthur Hillier, O.B.E., J.P., has announced details of a substantial reorganisation in the company's administration.

The main objective is a decentralisation of management and the establishment of three separate operating divisions, each embracing its own sales, design and manufacturing effort. These three divisions will be known as the Brentford, Bracknell and Industrial Divisions.

Sperry's rapidly growing interests in industrial control engineering will be concentrated in the new Industrial Division. These interests include hydraulics for both industrial and aircraft applications, electro - mechanical components, such as synchros, inductive pick-offs and similar servo units, process control components and systems, automatic machine control, measuring systems and components, non-destructive testing equipment, control systems and instrumentation for nuclear energy projects and for process control work.

The Brentford Division will be responsible for the company's aeronautical, marine and naval activities, whilst the Bracknell Division will concentrate on Government contract work for guided weapons and inertial navigation.

In disclosing these changes in the organisational structure, Mr. Hillier also announced the election of Mr. Robert Broadbent as a managing director of the company, under whose direct executive control the three divisional managers will operate. Mr. Broadbent has been director and general manager of the company for some years past.

Manager of the Industrial Division will be Mr. M. L. Jofeh, O.B.E., formerly the company's chief engineer, and further executive appointments in this division's sales organisation include Mr. D. Burns as sales manager and manager, process control; Mr. W. G. Lisle as manager, machine systems; Mr. D. McNaught as manager, electro-mechanical components; and Mr. F. G. Bradbury as manager, Vickers hydraulics.

Manager of the Brentford Division will be Wing Commander J. C. G. Bell, who relinquishes the position and title of sales manager but continues to be a director of the company. Mr. H. B. Sedgfield, M.B.E., is appointed manager of the Bracknell Division and relinquishes the position and title of engineering director but continues to be a director of the company. A new factory has recently been built in the New Town for this facility and is now rapidly coming into full operation.

Mr. P. C. Ruggles

English Electric Valve Co. announce that Her Majesty The Queen has honoured one of their senior engineers, Mr. P. C. Ruggles, B.Sc., conferring upon him the title of Member of the British Empire.

Mr. Ruggles has been with the English Electric Valve Company since its inception, being concerned largely with research and development of microwave valves of national importance. It is for his work in this connection that the award has been made.

Metropolitan-Vickers Appointment

Metropolitan-Vickers Electrical Co. Ltd. announces the appointment of Mr. H. West, Assoc.M.C.T., Hon.M.Sc. (Manchester), M.I.Mech.E., M.I.E.E., Member A.M.E.M.E., as assistant managing director. Mr. West ceases to act as director of Electrical Engineering from the same date.

New Manager of Crompton Parkinson Limited Development and Research Department

Mr. J. G. P. Anderson, B.Sc., F.Comm.A., A.M.I.E.E , A.M.B.I.M., has been appointed manager of the Development and Research Dept. Mr. Anderson joined Crompton Parkinson Ltd. in 1939 as a graduate apprentice from Edinburgh University and until his new appointment was manager of the A.S.T.A. Short-Circuit Testing Station at Chelmsford.

Circle 55 for further information

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This counter embodies all the well tried features of our Type 100 Electric Counters, plus electric reset. This form of reset is particularly useful where a number of counters are required to be reset at the same time.
Coils for both resetting and counting can be supplied for operation on the following voltages:—

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Mr. R. A. Bent.

Mr. R. A. Bent

Lancashire Dynamo announce the appointment of Mr. R. A. Bent, A.M.I.E.E., A.M.Brit.I.R.E., to the Board of Lancashire Dynamo Holdings Ltd.

Mr. Bent, who was born in Stafford in 1922, is managing director of Lancashire Dynamo Electronic Products Ltd., Rugeley, a company of which he was one of the founders, in 1946.

A.E.I. Appointments

The A.E.I.-John Thompson Nuclear Energy Company Limited announce the following appointments as from the 1st January, 1959.

Mr. S. A. Ghalib is appointed general manager of the company.

Mr. J. R. M. Southwood is appointed chief engineer.

Mr. B. M. Bonfield is appointed secretary of the company, and Mr. A. R. I aing will be assistant secretary.

Mr. Ghalib, who was a College apprentice at Metropolitan-Vickers Electrical Company Limited, was appointed a group leader of the A.E.I.-John Thompson Nuclear Energy Company Limited in September, 1954, and, on the formation of the company in 1956, was made chief engineer.

Mr. Southwood obtained a B.Sc., A.M.I.E.E. at St. Andrews University and, after serving in the Army, became a College apprentice at Metropolitan-Vickers Electrical Co. Ltd. In 1954 he joined the A.E.I.-John Thompson Group under Mr. Ghalib.

Head of Airborne Radar, R.R.E.

The Ministry of Supply announces that Dr. T. S. England has been appointed Head of Airborne Radar at the Royal Radar Establishment, Malvern. He took up duty at the beginning of the year.

Belgium Honours Westool Chairman

Mr. B. A. Williams, C.B.E., M.I.P.E., chairman of Westool Limited, St. Helen's Auckland, County Durham, and Williams and Williams Ltd., Chester, has been appointed a Commander of the Order of the Crown of Belgium.

The award has been made in recognition of his services to Belgian industry.

Sunvic Controls' Sales Managers

Sunvic Controls Limited announce alterations in their sales organisation. Mr. C. E. Walters has been appointed general sales manager covering all of the company's products but, in addition, is retaining responsibility for the Domestic Products Division. Sales managers of other divisions are: Mr. R. Lloyd, Scientific and Industrial Products; Mr. J. M. Anderson, Pneumatic Instruments: Mr. W. J. Donnelly, Data Processing. Manager of the Contracts Section is Mr. E. C. Bird.

Automatic Welding Appointment

Mr. Matthew Hudson has joined the staff of Rockweld Ltd. as an automatic welding engineer. He will be responsible for preparing automatic welding schemes in the application of the Rockweld Autopak automatic welding equipment.

Mr. Hudson has had wide experience of automatic welding, particularly in the construction of pressure vessels, as well as in shipbuilding and a wide range of engineering applications. He is a qualified radiographer.

Mullard Director's 25 years' Service

Dr. J. D. Stephenson, M.Sc., Ph.D., M.I.E.E., a director of Mullard Limited, has completed 25 years of service with the company.

Dr. Stephenson joined Mullard in 1933 from Durham University where he took degrees in physics, applied science and electrical engineering and did four years of research work. During his service with Mullard he has been concerned with all aspects of the company's manufacturing activities.

He has been a director of The Mullard Radio Valve Co. Ltd. and of Mullard Blackburn Works Ltd. for several years, and in 1956 was appointed a director of Mullard Ltd.

New Chairman Appointed for Texas Instruments Limited—Bedford

Mr. Cecil Dotson, of Dallas, Texas, U.S.A., has been appointed chairman of the board of Texas Instruments Limited, Bedford—first European subsidiary of the American organisation and largest manufacturers of silicon semiconductors (transistors) in this country.

Mr. Dotson joins the expanding British company as efforts are intensifying for an even wider acceptance of its transistors and rectifiers in the United Kingdom and European industrial markets.

An extensive new plant is planned for erection on a site of 240,000 square feet at Hoo Farm, Bedford. Building commenced early this year and by 1963 it is expected that 1,400 people will be working for the company.

Mr. C. Dotson.

Mr. J. Lasenby.

Mr. J. Lasenby

Messrs. Everett Edgcumbe announce that Mr. J. S. Lasenby has recently been appointed sales manager, operating from the head office at Colindale. Mr. Lasenby, who received his technical training at the Paddington and Wandsworth Technical Colleges, is the third ex-apprentice of the company to be promoted to a managerial post, two earlier appointments being those of chief engineer and chief of test respectively.

Mr. J. A. Hayward

Mr. J. A. Hayward, who since demobilisation from the R.A.F. in 1946 has been serving the Firth Cleveland Group as a director of overseas companies in South Africa, West Indies, U.S.A. and Canada, has now in addition been appointed to the board of Firth Cleveland Limited, 8 Cleveland Row, S.W.1, of which company Mr. C. W. Hayward is chairman and managing director.

Award to Distinguished Commonwealth Engineer

The Council of The Institution of Mechanical Engineers have awarded the 1959 James Watt International Medal to Sir Claude D. Gibb, K.B.E., D.Sc., M.E. (Adelaide), M.I.Mech.E., M.I.E., Aust., F.R.S., as an engineer who has achieved recognition both by his work as a mechanical engineer and by the ability with which he had applied science to the progress of mechanical engineering. Sir Claude Gibb was nominated by the Institution of Engineers, Australia, and the Institution of Mechanical Engineers.

It was intended to make the presentation to Sir Claude Gibb at the meeting of the Institution at 1 Birdcage Walk, Westminster, S.W.1, at 6 p.m. on Friday, 23rd January, but in view of his sudden death these arrangements were modified and, at the meeting an appreciation was given of the work of Sir Claude, and arrangements announed for the transmission of the medal to Lady Gibb.

Award of Benjamin Franklin Medal

With the approval of H.R.H. The Duke of Edinburgh, president of the Royal Society of Arts, the Benjamin Franklin Medal for 1959 has been awarded to Henry George Nelson, M.A., M.I.C.E., M.I.Mech.E., M.I.E.E., managing director of The English Electric Co. Ltd., for his work in scientific industrial development. The award is made annually to individuals who have attained early distinction, with promise of future achievement, in the promotion of arts, manufactures and commerce.

The **HIGH** linearity **LOW** friction **TACHO**

The high linearity of the output of the L.S.E. direct current tachogenerator (resulting from the absence of an iron mass in the armature) is of particular value for use with computing or integrating systems.
Desirable 'low' characteristics include low inertia, low friction torque and low ripple content.

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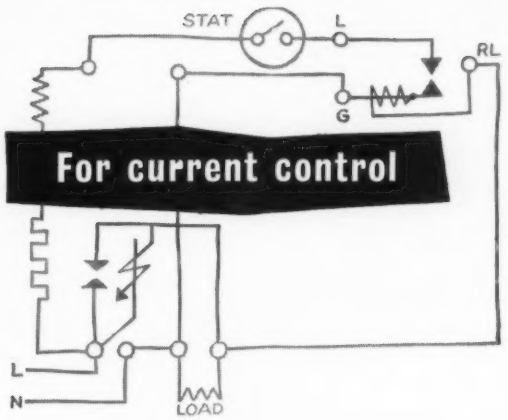
D.C. output 20 volts into 20,000 ohms at 1,000 r.p.m.
Linearity 0·25% up to 1,500 r.p.m.
Temperature coefficient 0·013% per °C.
Ripple content less than 5% at 1,500 r.p.m.
Moment of inertia 0·52 oz - in.²
Friction torque less than 20 grm. cms.

For fuller details of this and other L.S.E. instruments, write to:

LAURENCE, SCOTT AND ELECTROMOTORS LTD.

Instrument Department, Openshaw, MANCHESTER



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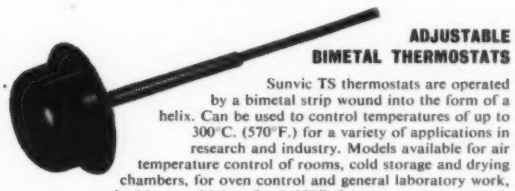
Sunvic components are widely used for controlling equipment such as moulding presses, furnaces, incubators, chemical plant, etc. Together with the Sunvic potentiometric recorder they also have numerous applications in scientific and industrial research particularly for measuring controlling and recording temperature and small electrical quantities.

If you have a specific problem or would like technical information on any or all Sunvic components, please contact Sunvic Controls Ltd., P.O. Box 1, Harlow, Essex. Tel: Harlow 25271.



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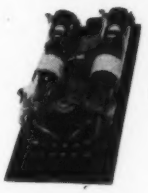
Sunvic TS thermostats are operated by a bimetal strip wound into the form of a helix. Can be used to control temperatures of up to 300°C. (570°F.) for a variety of applications in research and industry. Models available for air temperature control of rooms, cold storage and drying chambers, for oven control and general laboratory work, and with a sensitivity of ±1/10°C. for very accurate control.

ENERGY REGULATORS

The Sunvic energy regulator effects its control by periodically switching on and off the power, the ratio of the on-time to the total time determining the average power input, which is continuously variable. Available in several forms with a continuous rating of 1kW at 230V. A.C.; also supplied with an HVS relay for larger loads.



HOTWIRE VACUUM SWITCH (HVS) TUBES AND RELAYS

Available either as a loose tube for switching up to 10 kW at 400V. A.C. or D.C. or as a complete relay either enclosed in a plastic box or mounted on a paxolin base for incorporation in customer's own equipment. For single—or three-phase A.C. applications. Advantages are: no arcing; silent operation; low, non-inductive operat ng current; A.C. or D.C.; inductive or non-inductive loads.

SUNVIC *Control and research equipment for science and industry*

An A.E.I. Company **relays, thermostats, time delays, energy regulators, D.C. amplifiers and potentiometric recorders**

SC/68

Mr. Nelson is generally responsible for all the firm's electrical engineering, steam turbine engineering, diesel engineering, guided missiles, aircraft, electrics, computers and locomotives. He is also one of the three executive directors of a consortium responsible for a contract to build the world's largest atomic power station at Hinkley Point, Somerset.

His membership of Government Committees includes the Engineering Advisory Council and the Advisory Council for Middle East Trade. In addition he serves on the Management Committee of the Society of British Aircraft Constructors Ltd., and has also represented the engineering industry at a number of international conferences.

This is the third award of the Benjamin Franklin Medal, which was instituted in 1956 to commemorate the 250th anniversary of Franklin's birth and his election to membership of the Society of Arts in 1756. The two previous recipients were Professor F. C. Williams, F.R.S., in 1957, and Mr. Peter Ustinov last year.

BICC New Appointments

British Insulated Callender's Cables Limited announce the appointment of Mr. G. N. Blades, A.M.E.M.E., as regional manager, London, in succession to Mr. E. A. Sayers, who retired on 31st December, 1958. Mr. Blades was formerly divisional sales manager (Rubber Cables) at the Leigh Works and this position has been taken by Mr. D. I. S. Hinton, B.A. (Mech. Science). Prior to his official appointment on 1st November, 1958, Mr. Hinton was the BICC sales engineer (Aircraft).

E.E.A. Deputy Secretary

Mr. A. S. Marshall has been appointed to the new post of deputy secretary to Mr. H. E. F. Taylor, secretary of the Electronic Engineering Association, 11 Green Street, W.1.

Mr. Marshall was called to the Bar (Middle Temple) in 1957 and has completed a pupillage in chambers, specialising in Admiralty and commercial law.

Mr. F. E. Varlow

Mr. F. E. Varlow, B.Sc., sales director of Audley Engineering Company Limited, has assumed overall responsibility for a newly-created department to handle Audco Annin Products.

Mr. R. C. Archbold has been appointed manager of the new department handling Audco Annin Products.

Tour by Chairman of Griffin & George Company

On the 17th January, Mr. K. G. Sinclair, chairman of the Griffin & George Group of Companies, left London for a tour of India, Singapore, Australia and New Zealand. He will be returning to the United Kingdom on the 22nd March.

Mr. Sinclair's goodwill tour coincides with the publication of the Group's most recent catalogue of physical and laboratory apparatus, and he will be carrying with him the first copy of this 350-page catalogue.

Mr. Sinclair will be re-establishing many contacts through specific invitations but he hopes that he will have the pleasure of meeting may other customers in the towns on his route.

Mr. J. S. Fleuret

Northey Rotary Compressors Ltd. announce the death after a long illness of their sales director, Mr. J. S. Fleuret.

Plessey Executive Awarded M.B.E.

Mr. A. C. Emery, chief draughtsman of the Telecommunications Division of The Plessey Company Limited at Ilford, has been awarded the M.B.E., it was announced in the New Year's Honours List.

Mr. Emery, who has been with Plessey for twenty years, was seconded to the Signals Research Development Establishment during the war for two years.

Sales Representative for East and West Africa

Mr. W. Wanstall has been appointed sales and technical service representative by Chloride Batteries Ltd., Grosvenor Gardens House, Grosvenor Gardens, London, S.W.1, to cover the territories of East and West Africa. He will be responsible for developing, in conjunction with established agents, sales of Exide automotive batteries, Exide-Ironclad traction batteries, Chloride stationary batteries and Keepalite emergency lighting equipment.

English Electric Managerial Appointments

The English Electric Company Ltd. announces that in view of the continuing expansion of the company at home and overseas and of the wider responsibilities now carried by members of the central management, the appointments of the following executives have been re-designated as follows:—

Mr. E. B. Banks, A.M.I.E.E., is appointed director of commercial policy, contracts and sales;

Mr. P. L. de Laszlo, O.B.E., is appointed director of corporate affairs;

Mr. W. M. Hurton is appointed director of group manufacturing development;

Mr. L. H. Short, M.C., M.I.E.E., M.Inst.T., is appointed director of overseas operations.

Lancashire Dynamo Electronic Products Limited, Appointment of Chief Engineer

Mr. K. A. Robinson, of Lancashire Dynamo Electronic Products Ltd., was on the 1st January, 1959, promoted within the company to a new appointment as chief engineer. In this position he will be responsible for application engineering aspects of the operations of the company. Mr. W. F. Hill has been appointed chief development engineer with L.D.E.P., taking over the position formerly held by Mr. K. A. Robinson.

New E.M.I. Appointments

Mr. D. G. Ashton Davies has now taken up his appointment as sales manager of the Instrument Division of E.M.I. Electronics Ltd.

The Instrument Division markets a wide range of electronic test equipment, industrial measuring apparatus, closed-circuit television and nucleonic instruments.

Mr. Ashton Davies has had considerable experience in the electronics industry and has previously held positions with Marconi Instruments Ltd., and Mullard Ltd. He comes to E.M.I. from British Physical Laboratories Ltd. where he has been sales manager for the past two years.

Another new E.M.I. Electronics' appointment is that of Mr. Charles Kramskoy, who now becomes chief engineer of the Commercial Division.

Mr. Kramskoy was previously responsible for the development work on the company's new EMIDEC 2400 computer which has been developed in collaboration with the National Research Development Corporation.

I.C.T.

International Computers and Tabulators Ltd. (I.C.T.) is the name of the company resulting from the merger of The British Tabulating Machine Co. Ltd. and Powers-Samas Accounting Machines Ltd., and is Britain's largest manufacturer and distributor of data processing machinery. I.C.T. employs about 15,500 staff and its assets are valued at nearly £24m.

The chairman of I.C.T. is Sir Cecil M. Weir, K.C.M.G., K.B.E., M.C. He has been a chairman of the British Tabulating Machine Co. Ltd. since 1951, and is also a director of the Pyrene Co. Ltd. and British Enka Ltd. and a part-time member of the British Transport Commission. Sir Cecil Weir was president of the Institution of Production Engineers in 1952-53 and is an honorary freeman and liveryman of the Worshipful Company of Leathersellers.

One of the factors which initiated the merger of the companies was the emergence of the Common Market and the Free Trade Area.

As a result of the merger I.C.T. will be able to cover a wider market with more varied equipment than was covered by either company separately, and will be able to supply either electro-mechanical, mechanical, or electronic punched cards and computing equipment.

Both B.T.M. and Powers-Samas have invested heavily into research into and development of orthodox punched card equipment and both companies have been undertaking research into high-speed printing. The merged company therefore has available not only the sum of the techniques and specialist knowledge of B.T.M. and Powers-Samas but also that derived by B.T.M. from its association with The General Electric Co. and with the Laboratory for Electronics in Boston, U.S.A., and by Powers-Samas from its association with Ferranti Ltd.

The technical aim of I.C.T. will be to supply the market with the best punched card equipment from both companies, and among the amendments to be undertaken will be the standardisation of the 80 column card. A further aim is to provide a range of electronic computers sufficiently flexible to meet the needs of small, medium and large users in commerce, industry and Government.

Circle 58 for further information

LLOYD PARKINSON PANELS

DESIGNED TO INDIVIDUAL REQUIREMENTS

Manufactured by Craftsmen

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LLOYD PARKINSON LIMITED

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By far the clearest

The NEW Cambridge **CONTROLLER**

with illuminated centre-line display

This gives by far the clearest indication of control situation even at distances from which the scale graduations cannot be read. The scale is projected optically on to a translucent screen and can be set to bring the "desired value" in line with a fixed datum on the centre line of the instrument. When a *moving* pointer is also in line with this datum, the plant is "on control", and any deviation is immediately visible.

The controller is available in a simple ON-OFF version or as a time-modulated 3-term control instrument. The latter is a practical and economical alternative to instruments using saturable reactors, power positioned variable transformers, and similar expensive control devices. The same "error display" system is used in both versions.

Send for NEW List 28Y. For future publications, ask for Mailing Form Y/12/58.

CAMBRIDGE INSTRUMENT CO. LTD. 13 GROSVENOR PLACE, LONDON, S.W.1

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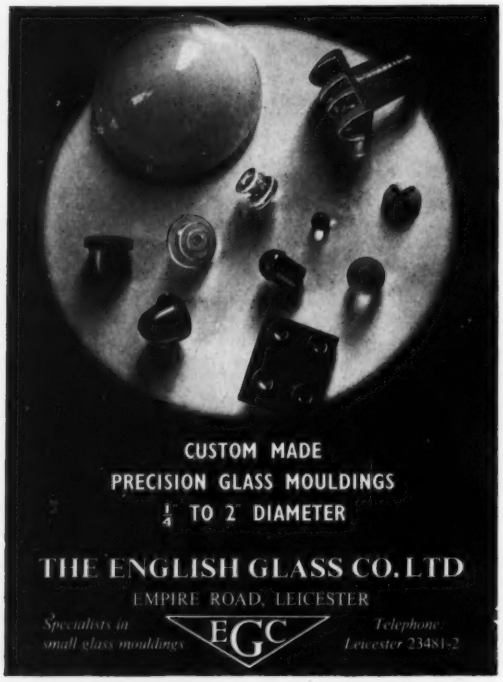
Circle **60** for further information



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Stitched Instrument Cases and Covers in leather and cloth, "made to measure", to fit your own products—also moulded to give a streamlined effect.

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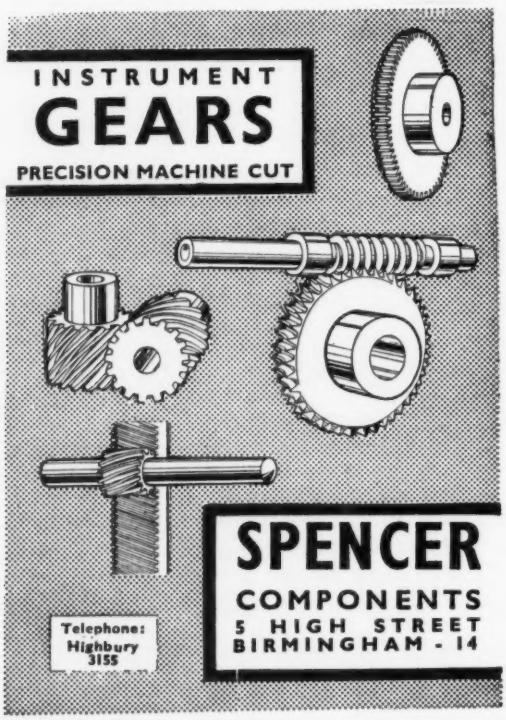

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Rates for other advertisements may be had on application to:

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9 Gough Square, London, E.C.4
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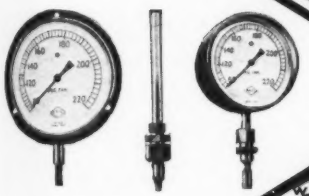
RECORDING INSTRUMENT
CO.

vapour
pressure
thermometers
for industry



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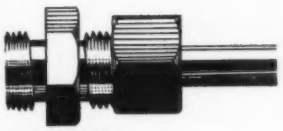
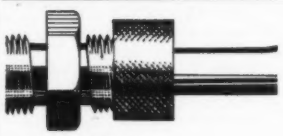


COPPER

whatever
the tube . . .



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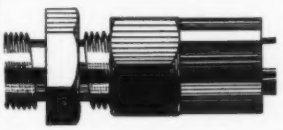
"WADE" to join it



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Copper .... plastic .... copper and plastic, it makes no difference to us. We design couplings for all kinds of tubing–with straight, tee or elbow fittings in sizes to suit most people.

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The output current of the Compensating Amplifier is directly proportional to the input signal (d.c. current or voltage).

Amplifiers are used for the following applications:

Wattless amplification of small d.c. voltages and currents of the type appearing in the output circuit of chemical and physical active or inactive transmitters.

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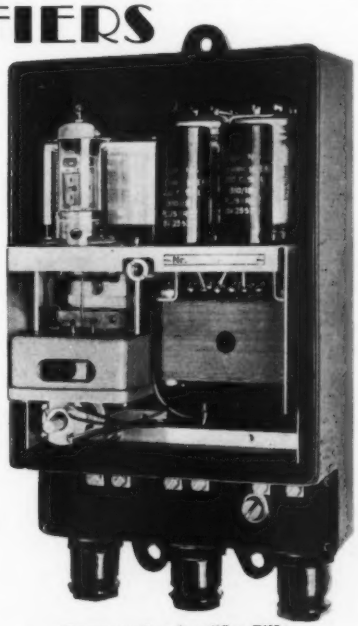

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The Proprietors reserve to themselves the right to refuse to insert an advertisement if they think proper to do so. All possible care is taken to ensure accuracy in setting up the advertisements, but should an error be made the Proprietors will not hold themselves responsible in any way for same.

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INSTRUMENT ENGINEER, 37, H.N.C. Returning from overseas during April on completion of contract, seeks change in U.K. or overseas. Twenty years' experience on instruments, 9 years instrument engineer. Experience in application, installation, maintenance and development of most forms of industrial instrumentation, particularly as regards to the chemical, smelting and petroleum industries. Box 708.

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NORTH WESTERN GAS BOARD (Liverpool Group) invites applications for the pensionable position of Instrument Engineer (Male). Minimum qualifications: Ordinary National Certificate in Electrical or Mechanical Engineering, or Ordinary Level G.C.E. in Physics, Mathematics and English. Some instrument experience would be an advantage.

Salary will be in accordance with A.P.T.4/5 (£481/£709 p.a.). The successful applicant will be required to pass a medical examination.

Apply by letter addressed to the Chief Personnel Officer, N.W.G.B. (Liverpool Group), Radiant House, Bold Street, Liverpool, 1, within seven days (quoting Ref. 38/135).

TECHNICAL ASSISTANT

required by Cambridge Instrument Co., at North Finchley, for Development and Investigation work on Mechanical Thermometry. Applicants should be between the ages of 18-25, with a minimum of O.N.C. and preferably H.N.C. (Mech. or Elect.). Experience of Mechanical Thermometry an advantage but not essential.

Write to:—

Ref.: S.R., Cambridge Instrument Co. Ltd., Friern Park, North Finchley, London, N.12.

LARGE OIL COMPANY

requires an

INSTRUMENT ENGINEER

for service in the Middle East. Applicants should have undergone apprenticeship and have had 4 years' experience with a reputable firm on continuous control instruments—predominantly mechanical/pneumatic. Gross pay not less than £1,700 per annum. Annual leave with paid passages. Fully furnished air conditioned accommodation at nominal rental. Excellent amenities. Bachelors under 35 should write in full, quoting No. 882 to Box No. 2309, c/o Charles Barker & Sons Ltd., Gateway House, London, E.C.4.

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The Guest, Keen & Nettlefolds Group Research Laboratory

requires a Physicist to strengthen the Non-Destructive Testing Research and Development Unit.

There are two main fields of work:—

(1) The development of new non-destructive testing instruments from basic principles. Some electronic engineering experience would be an advantage, as well as a good education in general physics.

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Excellent facilities and a pleasant and creative working atmosphere are provided in our new Research Laboratory building in Wolverhampton.

Applications, quoting reference G/6, should be addressed to:—

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Vacancies exist for Senior and Junior Engineers for work on major projects in the field of inertial navigation and associated systems.

Age Group: Senior Engineers 30-35 years.
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It may be necessary in certain cases to make short term visits to Australia.

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   - (a) **Precision mechanical assemblies.** **Ref. No. 5/MD**
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   Analysis and design of high performance miniature servo systems.
2. **For design of mechanical and electronic test equipment.** **Ref. No. 8/TS**

Candidates for design and development posts are expected to have a University Degree, and/or H.N.C., although proof of outstanding practical ability may be accepted in lieu of academic qualifications. A knowledge of aircraft and G.W. instrument practice advantageous. Salaries commensurate with qualifications and experience.

Write for application forms to:

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Nr. Cheltenham, Glos.,
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are required by the

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Applications are invited from experienced men with a knowledge of electronic equipment for fault diagnosis, repair and calibration of a wide range of instruments used in nuclear reactors, radiation laboratories and chemical plant. This interesting work involves the maintenance of instruments using pulse techniques, wide band and noise amplifiers, pulse amplitude analysers, counting circuits and television.

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There are accommodation, housing and lodging allowance arrangements.

Applications to:—

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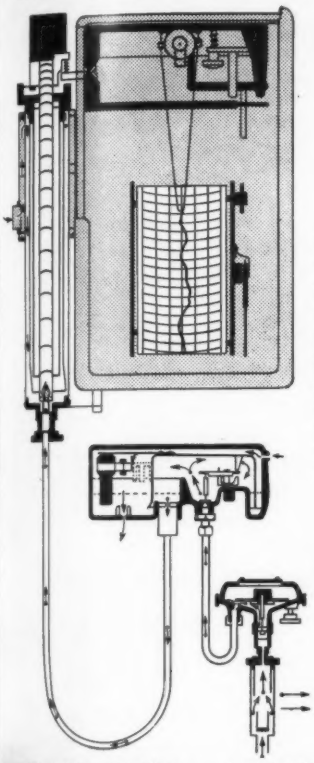

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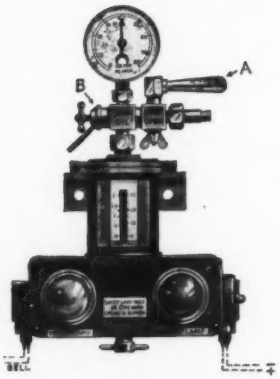

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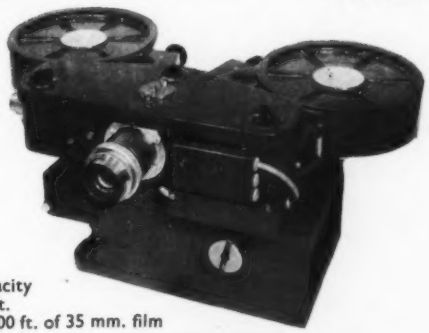

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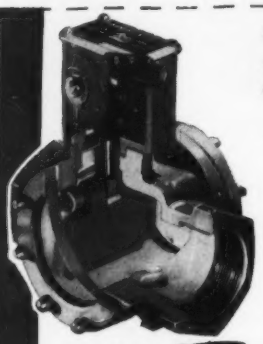

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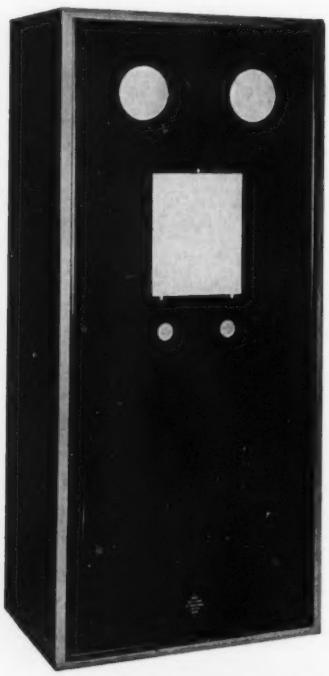

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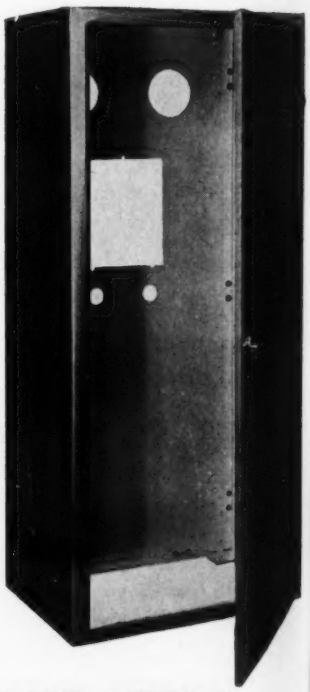

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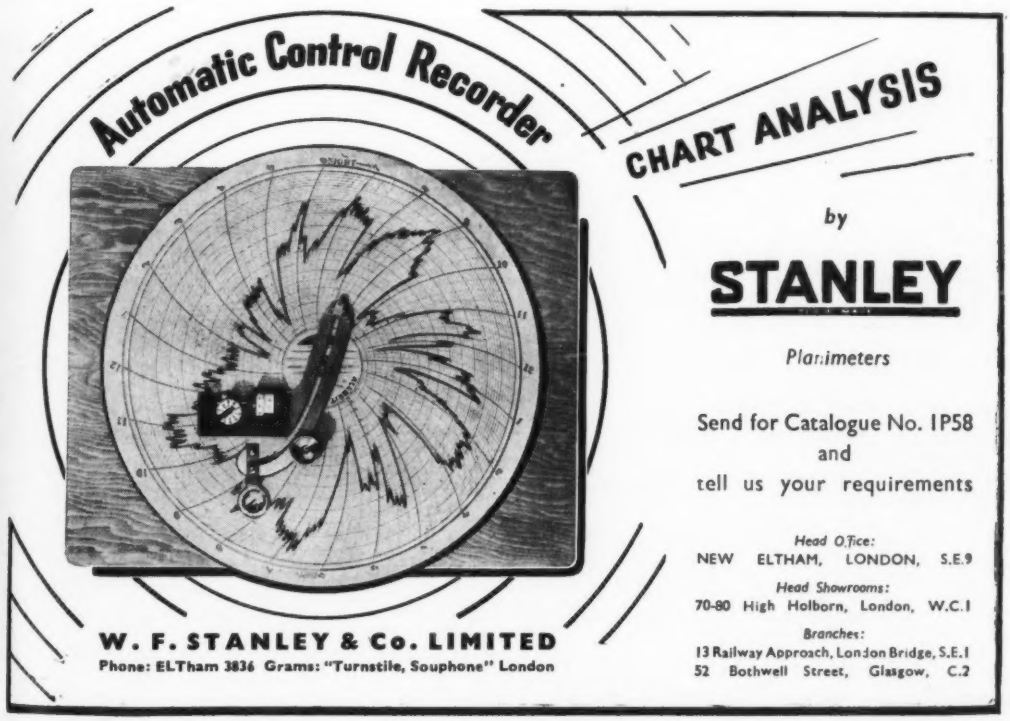

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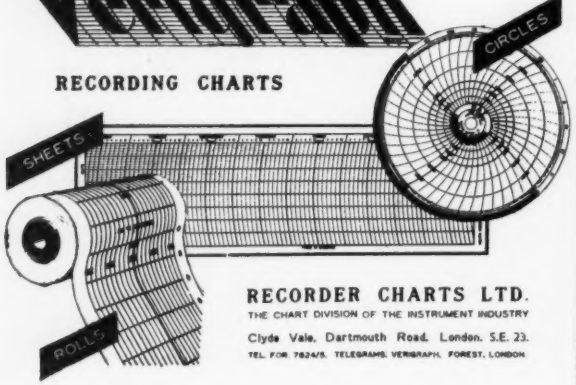

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